Department of Agriculture and Commerce,
N.-W. Provinces and Oudh.

FIELD AND GARDEN CROPS

OF THE

NORTH-WESTERN PROVINCES AND OUDH,

WITH ILLUSTRATIONS.

PART I.

BY

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PREFACE.

THIS volume is the first of a short series in which it is proposed to describe the cultivated products of these Provinces, and to furnish in a convenient form all the information on the subject that is likely to be wanted either by the student of Indian agriculture, or by the administrative officers of Government. It was originally intended to take its place as Part IV. of a series of works of reference published by this Department, of which the following numbers have already appeared:—

I. Gums and Resins.
II. Economic Mineralogy of the Himalayas.
III. Dyes and Tans.
V. Vegetables and Fruits.

Of these all but the third were written by Mr. E. T. Atkinson, C.S., who when he left these Provinces, bequeathed to the Department a large collection of notes, which has been used by Mr. Fuller in putting together these Papers. By far the greater part, however, of the present work has been compiled from the reports of Settlement officers and other Government records, or, as far as it deals with agriculture, practical or scientific, contributed by the author from the experience he has gained in managing the Cawnpore Experimental Farm, and the knowledge acquired in tours over the greater part of the Provinces.

For the purely botanical notices which form the first paragraph of each paper, the botanical determination of each plant figured, the selection of suitable specimens, and the general supervision of the plates both while they were in the Draughtsman's hands, and while they were passing through the Press, it is indebted to Mr. Duthie, the Superintendent of the Botanical Gardens at Saháranpur. The pictures are by Mr. H. Hormusji, a Parsee artist, who was imported by Mr. Buck in 1878 from the Bombay School of Art. The rest is by Mr. Fuller.

He is believed to be the first who has attempted to give a comprehensive view of the agriculture of these Provinces, and if the extent of area, the differences of custom and natural conditions, and the variety and complexity of the subjects forbid the expectation that the treatment has been quite exhaustive, it is hoped that the omissions are unimportant, and that serious mistakes have been avoided.

W. C. BENETT.

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Introduction.

THE following brief summary of the leading facts, which are of general application to the Agriculture of these Provinces, is merely given in order to prevent unnecessary recapitulation in the crop accounts, and the information which it contains has no pretensions to be considered very full or in any way exhaustive.

The total area of the N.-W. Provinces and Oudh is nearly 68 million acres, of which only 34½ million acres are under cultivation. Of the uncultivated area, 15 million acres, or 44 per cent., are returned as cultivable, and the remainder absolutely barren. Details of the area comprised within each Revenue Division of the N.-W. Provinces and the Province of Oudh are given below :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division.	Benares Division.	Jhansi Division.	Kumaun Division.	Oudh.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Cultivated, ...	44,39,680	44,00,320	40,36,928	50,04,928	64,22,144	13,78,184	5,06,752	84,00,896	3,45,84,832
= per cent. on total, ...	61·3	63·2	62·1	56·9	54·7	43 0	6·3	54·2	50·9
Uncultivated but cultivable, ...	16,36,608	19,09,056	10,88,448	20,30,272	20,82,560	11,94,496	7,54,240	43,18,336	1,50,14,016
= per cent. on total, ...	22·6	27·4	16·8	23·1	17·8	37·5	9·5	27·7	22·1
Uncultivable, ...	11,68,448	6,55,680	13,71,200	17,61,984	32,30,976	6,21,824	66,99,200	27,98,336	1,83,07,648
= per cent. on total, ...	16·1	9·4	21·1	20·0	27·5	19·5	84·2	18·1	27·0
Total, ...	72,44,736	69,65,056	64,96,576	87,97,184	1,17,35,680	31,89,504	79,60,192	1,55,17,568	6,79,06,496

The large amount of uncultivable land in the Kumaun Division results from its including but little flat country, and being almost entirely confined to the ranges of the Himalayas.

The land revenue annually collected by Government amounts to Rs. 5,70,94,121, which is increased by certain additional cesses to Rs. 6,57,35,362. This falls at the rate of Re. 1·9 per cultivated acre, or Re. 1·3 per cultivated and cultivable acre. The following table shows the revenue Division by Division :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division.	Benares Division.	Jhansi Division.	Kumaun Division.	Oudh.	Total.
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.
Land revenue, ...	80,30,773	69,01,702	84,32,385	93,37,287	81,94,375	14,99,474	5,16,254	1,41,81,871	5,70,94,121
Additional cesses, ...	14,14,434	13,17,881	14,19,056	16,20,550	15,07,543	2,86,650	56,321	10,18,806	86,41,241
Total, ...	94,45,207	82,19,583	98,51,441	1,09,57,837	97,01,918	17,86,124	5,72,575	1,52,00,677	6,57,35,362
Revenue per cultivated acre, ...	2·12	1·86	2·43	2·18	1·51	1·30	1·12	1·80	1·89

The rental may be assumed to be double the revenue plus cesses ; its amount is not even approximately ascertainable, since a large proportion of the cultivators are also landholders, and hence pay no actual rent.

The total population of the N.-W. Provinces and Oudh as returned by the census of 1881 was

44 millions, 30* millions of which (or 68 per cent.) derive their living directly from the soil. Out of these 30 millions, 15 millions are returned as actively occupied in the capacity of landholder, tenant or labourer in the following proportions, figures under hundreds being represented by cyphers :—

Landholders—	Male,	...	...	...	9,77,900	
	† Female,	...	...	...	2,18,900	
			Total,	...	11,96,800	= 7 per cent.
Tenants—	Male,	...	...	...	76,48,000	
	† Female,	...	...	...	29,14,600	
			Total,	...	1,05,62,600	= 70 per cent.
Labourers, in permanent employ—	Male,	...	...	...	8,34,300	
	† Female,	...	...	...	1,91,500	
			Total,	...	10,25,800	= 6 per cent.
Labourers, in occasional employ—	Male,	...	...	...	9,38,900	
	† Female,	...	...	...	11,80,800	
					21,19,700	= 14 per cent.
			Total labourers,	...	31,45,500	= 20 per cent.

The population of these Provinces is denser than that of any European country, and were it not possible that some portions of China may be still closer crowded with humanity, it might be confidently described as sharing with that of the Lower Provinces of Bengal the distinction of being the densest in the world. The number of persons to each square mile of area is 415, and if the hill districts of Kumaun be included, the figure is increased to 457. Excluding all uncultivated land, the number of persons supported by each square mile of tillage reaches the enormous figure of 808, and this too although the urban population does not amount to 10 per cent. of the total. There are considerable differences between the density of population in the various parts of the Provinces, as well as in the proportion in which ‡urban population stands to rural, as is indicated by the following table :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division.	Benares Division.	Jhansi Division.	Kumaun Division.	Oudh Division.
Population—								
per square mile of total area, ...	454	477	476	418	535	200	84	469
per square mile of cultivated area, ...	741	745	766	736	978	466	1,322	867
Percentage of urban population on total, ...	15	14	12	9	7	10	4	6

The density of population in the Allahabad Division would be even larger per cultivated mile than that of the Benares Division were not its limits extended to the Bundelkhand Districts of Banda and Hamirpur, which are geographically distinct from the rest of its area. The fact that the cultivated area of the Himalayan hill tract supports a larger population than that of any other portion of the Provinces is at first sight surprising, but indicates how closely density of population is connect-

* Obtained by calculation only, since means of livelihood was only taken note of in case of persons engaged in some occupation and not in case of their families.

† In their own right, wives merely as such are not included.

‡ "Urban" population includes the inhabitants of all towns consisting of a continuous group of buildings with a population of 5,000 souls and upwards.

ed with certainty of rainfall.* This consideration is also of assistance in accounting for the increase of population as one goes eastwards, even although concurrently with a diminution in the proportion of that portion of it which seeks its livelihood in trade and manufacture.

The most important class of the community from an agricultural point of view is of course the tenantry. Without touching on the complicated subject of land tenures, the cultivators of the Provinces may be broadly classified according as they hold their land under a right of occupancy at a fair rent, or are liable to be ejected at the pleasure of their landlord. The percentage of area held in occupancy right in 29 out of the 30 temporarily settled N.-W. Provinces Districts is shown by Divisions below.† The figures have been calculated from the agricultural returns for 1879-80:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Banda and Jaunpur.	Benares Division, including Basti and Gorakhpur only.	Jhansi Division.	Kumaun Division, including Tarai only.
Percentage of area held in occupancy right to total cultivated area,	16	29	33	30	15	6	23

Another important consideration in estimating the prosperity of the cultivating classes is the average size of holding. To ascertain this is a task of some difficulty, the only reliable source of information being Settlement officer's pargana rent-rate reports, which do not in every case contain the required statistics of the cultivating population. The subjoined table epitomizes the result of compiling all available information on this subject, and the differences which are brought out appear the more striking if the Districts for which figures are procurable are classed according to geographical position.

	Upper Doáb Districts of Saháranpur, Muzaffarnagar Meerut, Bulandshahr and Aligarh.	Middle Doáb Districts of Muttra, Agra, Etah and Mainpuri.	Lower Doáb Districts of Farukhabad, Cawnpore and Fatehpur.	Trans-Ghágra Districts of Basti and Gorakhpur.	Rohilkhand Districts of Bijnor, Moradabad, Bareilly, Pilibhit, Sháhjahánpur and Budaun.	Bundelkhand Districts of Jalaun, Hamirpur and Banda.
Average number of acres per holding—						
of occupancy tenants, ...	8·6	6·6	3·7	3·9	5·2	6·2
of tenants-at-will, ...	7·2	5·7	2·6	3·1	3·6	4·9

The decrease in size of holdings from west to east is very striking, and to indicate how naturally the different Districts fall into the classification which has been adopted, I cite below the average area of occupancy holdings in a few of them :—

In the Upper Doáb.		*In the Middle Doáb.*		*In the Lower Doáb.*	
Muzaffarnagar,	7·4	Etah, ...	6·6	Farukhabad, ...	3·6
Bulandshahr, ...	9·8	Mainpuri, ...	4·3	Cawnpore, ...	3·7
Aligarh, ...	9·5				

It is admitted that beyond doubt the cultivating classes of the Meerut Division are the most pros-

* An abundant demand for labour, and the difficulty of extending cultivation are concurrent causes.—W. C. B.

† In Oudh occupancy tenants are only ⅛ per cent., and are drawn exclusively from ex-proprietary classes.—W. C. B.

perous in the Provinces, and the large size of holdings there would seem to bear a significant relation to this. Density of population would be expected to furnish an explanation of these differences in the area of holdings, but it is very far from supplying a complete answer to the question. The difference between the holdings of Bundelkhand and the trans-Ghágra Districts is undoubtedly coincident with a great difference in population, but no satisfactory reason can be discovered from this source for the differences in the holdings of the Upper, Middle and Lower Doáb and Rohilkhand. The proportion of urban to rural population furnishes some clue in this case, being, as a rule, greater in Districts where the area of holdings are largest. The following table compares the density of population per cultivated square mile and the percentage of urban to total population, in the same groups of Districts as are referred to in the preceding table :—

	Upper Doáb Districts of Saháranpur, Muzaffarnagar, Meerut, Bulandshahr and Aligarh.	Middle Doáb Districts of Muttra, Agra, Etah and Mainpuri.	Lower Doáb Districts of Farukhabad, Cawnpore and Fatehpur.	Trans-Ghágra Districts of Basti and Gorakhpur.	Rohilkhand Districts of Bijnor, Moradabad, Bareilly, Pilibhit, Sháhjahánpur and Budaun.	Bundelkhand Districts of Jalaun, Hamirpur and Banda.
Population per cultivated square mile, ...	733·1	728·8	848·1	915·4	745·0	419·6
Percentage of urban to total population, ...	15	13	11	3	14	9
Ditto after deducting population of the city at each District head quarters, ...	11	7	8	2	8	6

The last line of figures has been added in order to give some indication of the *distribution* of the urban population, which has almost as much effect in lessening the pressure on the land as its actual amount.

The difference between the size of holdings in the Upper and Middle Doáb may be therefore partly due to the larger proportion of the population which is absorbed by towns in the former tract. The decrease in the size of holdings in the Lower Doáb is sufficiently accounted for by the large increase in density of population, coupled with a decrease in that portion of it which derives a living from trade or manufactures. Both these conditions are greatly exaggerated in the trans-Ghágra Districts, without, however, leading to any further diminution in the size of holding, possibly because it is already the smallest which can be made to find employment for a family. In these Districts, therefore, there is a large accession to the class of labourers, a large proportion of whom are literally as well as practically the bond slaves of their employers. The condition of slavery offers a refuge from the pressure of competition, and the certainty of daily food may be held some compensation for the loss of a liberty which only manifests itself in an insufficiency both of work and nourishment.

It may be mentioned here that the statistics in respect to the area under the different crops which are given in the following pages are reliable only in the case of the 30 N.-W. Provinces Districts, which are under settlement for a period of 30 years, and in which an elaborate system of land record is maintained. In the case of 12 Oudh Districts, the 5 N.-W. Provinces Districts under permanent settlement, and the hill Districts of the Kumaun Division, all figures which are given must be accepted as being merely approximate.

Seasons.

The agricultural year of these Provinces includes two complete seasons, the one, known as the kharif, embracing the rainy months of the summer and autumn, and the other (the rabi) the cold weather months from October to April. During the kharif the conditions of warmth and moisture are almost if not quite tropical, and the crops grown in this season (the numerous tribe of millets, maize,

rice, cotton, &c.) are all of a tropical or sub-tropical character. The rabi season on the other hand, with an average temperature but little in excess of that of the English summer months, is well suited for the production of the most characteristic crops of temperate latitudes, wheat and barley under good cultivation yielding a produce which is fully equal in quality and quantity to that obtained in England or America.

Both kharif and rabi may be divided into two sub-seasons. The native agricultural year commences with the first of the month of *Kuár*, (a date which varies on the solar calendar, but which corresponds on an average with the middle of September,) from which the sowings of the early rabi commence. These include mostly garden crops, such as *láhi** (*Brassica glauca*), *rámdána* (*Amaranthus frutescens*), carrots and vegetables of European origin (cabbages, broccoli, turnips, &c.), which ripen in January and February, two months before the regular rabi harvest commences. The sowing of the more important rabi crops, including all the cold weather cereals, commences in the middle of October, and continues till the middle of November, and although there is as a rule little or no rain after the end of September, yet the ground generally retains sufficient moisture to ensure the proper germination of the seed. The date of harvesting these crops vary a good deal in different parts of the Provinces, but in most districts they are all off the field by the middle of April.

The months of April, May and June constitute a sub-season, termed by natives *záid* or "extra," but which may be more conveniently treated as a portion of the kharif. The principal crops produced in these months are of the melon tribe, grown in manured pits on sand banks in the bed of a river, and the small millet known as *chehna* (*Panicum miliaceum*), which requires copious irrigation. These ripen in June. At the end of May or beginning of June indigo and maize are sown where irrigation is available, since both these crops should be got into the ground if possible at least three weeks before the rains commence—indigo, because excessive moisture is apt to damp off the young plants, and maize, because it is as a rule followed by a rabi crop, and it is therefore a great object to get it off the ground as soon as possible. Ploughing commences actively with the setting in of the rains at the end of June or beginning of July, the first crop to be sown being cotton, then rice, and the greater millet (*juár*), and last of all the spiked millet (*bájra*). It is of the utmost importance that all the land destined for rabi crops should be ploughed up at the beginning of the rains, so as to catch the rain in open furrow, and since the whole of the rabi should be ploughed and reploughed at least four times during July and August, the cultivator finds no lack of employment in the intervals between the weedings of his kharif crops.

Sugar-cane is somewhat exceptional in its season, being sown from January to April, and cut during the following cold season. It is most properly reckoned as a kharif crop.

Soils.

The soils over the greater portion of the Provinces being of alluvial origin, do not exhibit any such striking differences as are seen in a tract where they have been formed by the disintegration of rock *in situ*. The fluvial action to which most of the soils of the Provinces owe their origin, must have effected the more or less complete intermixture of the results of the denudation from which they are derived, and the main difference between one soil and another lies more in mechanical condition than in chemical composition. Local differences in the strength of the river current would result in the separation of the finer from the coarser particles of earth held in suspension, the latter sinking much slower than the former, and being therefore deposited in greatest quantity where the current was slowest—in still water channels and back waters. Differences in the size of particles are often associated with differences in chemical composition, and to some extent this process would, therefore, tend to the separate deposition of the particles of different kinds of substances, such as for instance

* In many Sub-Himalayan tracts *láhi* is an important field crop.—W. C. B.

clay and flint (sand). To the continual changes in the river bed and consequent variations in the currents must be ascribed the great irregularity in the distribution of sand and clay beds both above and below the surface, which is one of the most striking geological features of the Provinces. The irregularity in surface distribution must have forced itself on the attention of every one who has had occasion to examine the soils of even a single village, and that this irregularity prevails to a considerable depth beneath the surface is shown by the very different strata through which even closely adjacent wells are often found to have passed.

In the portions of the Provinces which lie north of the Jumna, soils are classified by native cultivators mainly with reference to the proportions in which clay and sand enter into their composition. The general term for a clay soil is *matyár;* if very stiff, such as is found along drainage lines, it is known (in the Eastern Districts) as *dokra*, and if of the poorest quality, only fit for rice cultivation, as *dhaukar* or *khaput*. At the other end of the scale a soil of almost pure sand is called *bhúr* or *balua*, while loams are collectively known as *domat*, local terms being *rosli* and *sèiwai* in the Meerut Division, and *seolah* in the Eastern Districts. The light reddish loam which is found over a great portion of the Provinces, and which is generally accompanied by extensive irrigation from earthen wells, is known as *sàigun* (Meerut), or more generally *pilia* or *pilotah*. *Usar* is the name applied to the reddish clay which is rendered infertile by saline matter.

In the tract known as Bundelkhand* south of the Jumna, soils exhibit much more diversity, the most characteristic of them being the stiff black loam called (*par excellence*) "cotton soil" or *már*. This stretches in extensive isolated plains over a large tract of country, and is of remarkable fertility, producing excellent crops of cotton, millets, wheat and gram without irrigation, and with very rough cultivation. Irrigation is rendered unnecessary in ordinary years by the great retentiveness of moisture which characterizes this soil, but even were it necessary it would be impossible, since *már* when dry splits up into fissures of surprising depth, one or two of which would effectually swallow up a whole day's watering. A lighter coloured *már* is known as *kábar*, which is also very sparsely irrigated. A grey loam which is greatly benefited by manure and water is called *parwa*, and *ránkar* is a light yellowish infertile soil which extends over a great portion of the country, especially in tracts intersected by ravines.

As to the alluvial origin of the soils of Bundelkhand there can be no doubt, and their dissimilarity from those north of the Jumna may be explained on the hypothesis that they were derived from Central Indian instead of from Himalayan *débris*. The chemical composition of *már* is compared below with that of the soil of the Government Farm at Cawnpore. The farm soil may be accepted as a fair sample of the light reddish loam which occurs over a large portion of the Ganges-Jumna Doáb. Both analyses were kindly made by Mr. S. A. Hill, B.Sc., Meteorological Reporter to Government, and represent the condition of the samples after having been freed from all uncombined water by exposure to a heat of 125 C.

	Composition per cent.			*Composition per cent.*	
	Cotton soil.	Farm soil.		Cotton soil	Farm soil.
Combined water, ...	3·21	2·04	Ammonia, ...	Trace.	None.
Organic matter, ...	† 1·74	0·16	Nitric pentoxide, ...	0·13	0·11
Carbon dioxide, ...	1·28	0·16			
			Total volatile constituents, ...	6·86	2·47

* Comprising the Districts of Banda, Hamirpur, Jalaun, Jhansi and Lalitpur.

† Containing 0·96 carbon.

	Composition per cent.	
	Cotton soil.	Farm soil.
Chlorine, ...	0·64	Trace.
Sulphur trioxide, ...	7·66	Trace.
Phosphorus pentoxide, ...	0·11	0·51
Silica and tungstic oxide (latter in farm soil only), ...	0·38	0·13
Alumina, ...	0·24	4·20
Oxides of iron and manganese,...	3·33	5·59
Lime, ...	3·66	0·90
Magnesia, ...	0·99	0·91
Potash, ...	0·28	0·32
Soda, ...	0·43	0·08
Total soluble in hydrochloric acid, ...	17·72	12·64

		Composition per cent.	
		Cotton soil.	Farm soil.
Clay decomposed by H_2SO_4	Alumina,... ...	7·57	2·94
	Oxide of iron, ...	0·10	
	Silica, ...	13·55	3·37
Insoluble sand, &c., ...		54·51	78·56
Grand total, ...		99·81	100·02

The dark colour of the cotton soil (which almost disappears on drying) is obviously not due to peat, as the proportion of organic matter is so small, but is probably caused by some compound of iron. The most notable point about its composition is the large proportion of gypsum it contains, the sulphuric acid and lime being in such quantities as to be equal to 6 or 7 per cent. of gypsum, even supposing some of the acid to be combined with magnesia, oxide of iron and other bases.

A notice of the soils of the Provinces would be imperfect without some account of (1), usar ; (2), kankar ; and (3), the nitrates which are found in the soil and well water of certain localities.

Usar.

Usar is the term applied to a yellowish clayey soil which is rendered infertile by containing an excess of soluble salts. These salts chiefly consist of sodic sulphate (Glauber's salts) generally accompanied by varying proportions of impure sodic carbonate. They often amount to as much as 20 per cent. on the weight of the surface soil, which is at least forty times the proportion consistent with fertility. Under conditions favorable to surface evaporation the salts accumulate on the surface, in some places covering square miles of country with a dazzling white efflorescence, which no one who has ridden across will easily forget. The extent of the loss which these salts entail may be judged of from the fact that out of the 64 million acres which form the total area of the N.-W. Provinces* and Oudh 2½ million acres, or 4 per cent., are returned as uncultivable, solely on account of being impregnated with them.

The most extensive tracts of usar are in the Districts of the Ganges-Jumna Doáb east of Meerut, where they amount to 11 per cent. on the total area. They occur but sparsely in the damper Districts of Rohilkhand, north Oudh and Benares, and are unknown in Bundelkhand.

The most striking fact in connection with usar land is the extreme irregularity of its distribution. Not only are usar plains of the most fantastic outline and often interspersed with small oases of fertile land, but frequently single fields may be met with containing narrow strips of usar only one or two feet broad in the midst of a luxuriant crop. It may still be considered a doubtful question whether the salts are peculiar to usar soil, and were originally deposited with it, or whether they have been concentrated in it from the surrounding soil either by a long-continued process of capillary attraction and surface evaporation, or by transfer over the surface in drainage water. But it may be accepted as certain that impermeability to the downward percolation of water is one of the most marked characteristics of usar soil, and this would of course enormously assist surface concentration,

* Excluding the hill tracts of Kumaun and Garhwal.

since it would prevent any salt from being washed more than a few inches down into the subsoil, when it had been once brought to the surface by capillary action.

Kankar.

Kankar is the name given to a form of carbonate of lime, closely resembling stalagmite, which occurs in beds a few feet below the surface, and is found here and there in most districts of the Provinces. It is especially common in the districts where usar is prevalent, and has been often ascribed as one of the causes of saline efflorescence, which it would undoubtedly assist by stopping all downward water percolation. It occurs in either irregularly-shaped nodules or in blocks ; in the former shape it furnishes the material for the metalled roads over almost the whole of the Provinces, and in the latter form it is an effective material for building purposes.

A curious fact connected with it is that exhausted beds are known to form again in a few years, if the holes from which they were dug are filled in and levelled.

Nitrates.

India has long been known as an exporter of saltpetre (potassic nitrate), its climate being peculiarly favourable to the oxidization of ammonia and consequent production of nitric acid. Nitrates occur largely in the soil and well water of numerous localities in every District of the Provinces. The places where they are found may almost always be recognized as village sites of great antiquity, and they are believed to be formed from the filtration of the sewage which saturates the ground of every alley in a village, and gives a manurial value to the water of the village tank. The nitrate which is found efflorescing on the surface of the ground, and which is particularly common on old walls, built with mud from the village tank, is nitrate of potash (saltpetre), and under the name of *nona mitti* is often used by cultivators as manure for tobacco. The nitrate found in brackish (or *khári*) well water is nitrate of soda (chili saltpetre), since nitrate of potash is held up by the soil and never therefore reaches the subsoil water. *Khári* water is of considerable manurial value to growing crops, but checks the germination of seed if applied before sowing, and hence villages which are dependent upon it are unable to supply by irrigation any deficiency of natural moisture at the time of sowing the rabi crops.

Manures.

It is a striking illustration of the natural fertility of the soil that the Indian cultivator can make shift with so little manure as he does, although the small size of the holdings allows the land but little rest, and much of it has been under cultivation from remote antiquity. The exclusion of animal food from the Hindu dietary, is an insuperable bar to the alternation of meat growing with corn growing, which is held essential on most English farms ; and two-thirds of the dung of what cattle are kept for draught and milch purposes is consumed as fuel, and only reaches the land as inorganic ash. The whole of the dung which falls in the homestead, and much of that which falls in the roads and fields during the dry months of the year, is collected by the women of the house, made into round flat fuel cakes and dried in the sun, and it is only in the rainy months, when it would be impossible to do this, that the dung finds its way on to the cultivator's muck heap. In an ordinary district there is one head of horned cattle to every two cultivated acres, plough cattle constituting rather less than half the total number, milch cattle (chiefly buffaloes) and calves forming the rest. The average weight of the sundried dropping of a bullock per diem may be taken as 4 to 5 lbs., so that even if the whole of the supply of cattle dung was carefully utilized and none burnt for fuel, the amount available per acre per annum would be only a little over 10 maunds. The keeping of sheep and pigs and goats is confined to the very lowest classes of the people, and is on so small a scale that it has little or no influence on agriculture.

The consumption of cattle dung as fuel is, however, necessitated by the scarcity of wood and impossibility of obtaining either peat or coal to fill its place, and there can be no doubt that a large proportion of cultivators make good use of the supply of manure which is available. The core and most valuable portion of the muck heap is the cattle dung collected during the rains, on which are

thrown each day the ashes from the cooking fire and all refuse vegetable food. No attempt is made, however, to prevent loss by drainage or evaporation, but the droppings of Indian cattle are so poor in nitrogenous matter, that it is probable that the loss from these causes is over-estimated. On the other hand villages are not uncommon in which no attempt is made to collect even the manure which is at hand, and the cultivators either from caste prejudice or force of custom will make no endeavour to manure their land.

The fields of an Indian village have, however, a source of manure peculiar to the country. An invincible objection is held by the villagers to anything in the form of a fixed privy, and the land immediately surrounding the village site is the favourite retiring place for its inhabitants. The value of this custom to the soil can hardly be over-estimated. It is mainly owing to it that each village is surrounded with a belt of rich land, several fields deep, which pays at least double the rent yielded by land at a short distance beyond it. Indeed the fields of a village may be nearly always marked off into three belts by differences in their manure supply. The one lying round the outside, called the *barha* or *pálu*, is never manured, the one next to it (the *manjha*) is manured in every second or third year from the cultivator's muck heap, while the one immediately surrounding the village (the *gauhán* or *bára*) is fertilized in the manner indicated above in addition to this.

It will not be out of place here to make brief mention of the systematic manner in which the refuse of certain towns is utilized by the cultivators who live round them. The city of Farukhabad is surrounded by a broad band of what is probably the highest cultivation in the Provinces. Three crops are gathered within the year: potatoes occupy the ground from October and February, are succeeded by tobacco, and the tobacco by maize, which is off the ground in time for the next crop of potatoes. Enquiries made by Mr. Buck in 1872, showed that this productiveness was entirely due to the use of the city refuse as poudrette, and that a regular system had organized itself for the transmission of the manure from the city to the cultivators. The city was divided into wards, each one of which was in charge of a set of scavengers or sweepers, whose sole remuneration for the daily removal of refuse and filth was the price which they could obtain from the cultivators for it.* It was calculated that the total annual price paid to the scavengers for the manure was about Rs. 20,000, while the increase in rental, which was due to its application, amounted to some Rs. 40,000 more. But this state of things is very exceptional, and is mainly due to the fact that the cultivators round Farukhabad are of a caste which permits of their using as manure refuse which in most cities is disposed of as fuel for brick burning.

The occasional use of earth containing nitrate of potash (saltpetre), especially for tobacco, has been already noticed, as has also the manurial benefit which results from the use of water impregnated with nitrate of soda (*khári*). In some places there appears to be a dim recognition of the advantages which result from ploughing in a leguminous crop, although it is hardly ever acted upon, probably because the advantage in present of cutting and carrying the crop outweigh the profit in future from using it as manure. No use is made of crushed bones, and careful experiments have shown that the increase in produce which they occasion is on many soils very small, if not altogether problematical. In indigo refuse, however, there is a most valuable fertilizer, which in these Provinces hardly ever finds its way on to the land being, as a rule, sold by the factory as fuel for glass making, when it fetches as much as Rs. 1-8 to Rs. 2 per 100 (dry) maunds. In Behar it is universally used as a manure, partly perhaps because the factories there have more land directly attached to them than is the case in these Provinces, and partly because no glass is made there, and the temptation to turn it into ready money does not exist.

Tillage.

The condemnation which is passed on the Indian method of tillage is, as a rule, far too sweeping.

* The same arrangement exists in Lucknow.—W. C. B.

The implements are it is true of the rudest kind, but the patience and perseverance of the cultivator compensate to a great extent for the inefficiency of his tools, and although a single ploughing may merely scratch the surface, the twelve or fifteen ploughings which are commonly given for the more valuable crops produce a tilth which for depth and fineness might be envied by any English market gardener. The smallness of the holdings render time of comparatively little value, and the general weakness of the cattle only permits of the land being ploughed, so to speak, by instalments. In places, however, where higher cultivation is spreading, and crops such as sugar-cane are more generally grown, the need of a more efficient plough appears to be felt as is shown by a great increase in the size and weight of the native implement. In general shape the plough is very similar to the one used in Egypt at the present day, and in England at the time of the Heptarchy. In its idea it may be considered a pickaxe drawn by bullocks, the handle being the plough beam, one arm of the pick the plough share, and the other arm the handle or stilt. It therefore tears and does not cut the ground, and weight for weight, and depth for depth, is infinitely heavier to draw than the modern ploughs of Europe or America. It is in fact a grubber not a plough, and merely stirs the earth without inverting it. Although there is a general similarity in the shape of plough throughout the Provinces, there are very wide differences in its practical efficiency. As a rule it may be said to consist of a short beam of wood (the body or *kúr*), in which are fixed (1), the beam (or *háris*) by which the plough is drawn; (2), the sole (or *paretha*) which carries an iron spike, (the *phára*), answering to the English share; and (3), the handle (*muthia* or *chiráya*). The general appearance of the plough varies with the angle at which these parts are attached to the body, the position of which varies from being almost perpendicular to being quite horizontal, in which latter case the plough sole is fixed into one end of it and both are in the same line. In some localities there is no separate stilt or handle, but the upper end of the body is prolonged upwards in a curve to serve the purpose, and in another common variety the stilt, instead of being fixed into the upper end of the body, is carried down behind it, and bolted to it by the hinder end of the beam which passes through them both.

The plough is at its worst in the rice districts of Oudh and the Benares Division, where it is of ludicrously small size, often only weighing 17 or 18 lbs. It is in these Districts too that the agricultural cattle are poorest and weakest, possibly on account of the poverty of rice straw as fodder. Speaking generally the efficiency of the plough may be said to increase as we go westwards, the ordinary plough of the central Doáb weighing about 28 lbs., while that of the Western Districts (Meerut, Muzaffarnagar and Saháranpur) weighs nearly 50 lbs., is bound with iron round the edges of the sole, and instead of a short spike for a share, has a long iron bar which projects behind, and can be thrust forward from time to time as its point wears down. At a long interval comes the *nágar* plough, used for cane cultivation in parts of Bundelkhand, which weighs 4 maunds, tears up the soil to a depth of 18 inches, and is drawn by eight bullocks, the cultivators clubbing their cattle together and ploughing their fields turn and turn about. Bundelkhand also has another characteristic implement, called the *bakhar*, or hoe plough, which is simply a large hoe drawn by bullocks and used for scarifying the surface in the rains.

The plough is frequently converted into an efficient seed drill by having a bamboo tube attached to its stilt, down which the seed can be dropped.

For breaking up the clods and levelling the ground, the implement in most general use is a heavy flat log of wood (the *henga*, *mai*, *patela*, or *páta*) drawn by two pairs of bullocks, the driver standing on it to increase the weight. In the Western Districts a roller (*lakkar*), neatly fashioned of the trunk of a tree, in common use especially for sugar-cane cultivation, and is generally preceded in the field by a light description of log clod crusher, called *maira*.

Tillage depends so greatly on the efficiency of the draught power, that a few words may be added on the cattle which are used for agricultural purposes. These are almost entirely bullocks, since buffaloes, though common in many parts of the Provinces, are not capable of continuous effort in a hot sun, and are further disqualified in some places by caste prejudice. Careful enquiry has shown that there is one plough bullock or buffalo for every 4½ or 5 acres cultivated. The bullocks may be either locally bred or imported. In the Eastern Districts local bred cattle are the rule, and in the Western Districts the exception, and it follows that the cattle of the Eastern Districts are the worst, and of those of the Western Districts the best, in the Provinces. In the Districts of the central Doáb, enquiries have shown that imported cattle constitute about 45 per cent. of the total. The principal breeding grounds in the Provinces are the jungles which fringe their upper and lower border below the Himalayas on one side, and the Central India hills on the other. So far as numbers go the Sub-Himalayan breeding tract is the most important, but for quality the Bundelkhand is very far superior.* But the tracts from which the best cattle are driven are those known as Mewat and Harriána, the former lying principally within the territory of native Rajputana States, and the latter in the Punjab Districts of Rohtak and Hissar. Thousands of cattle are brought annually from these tracts to the large cattle fairs held at Batesar, Makhanpur and elsewhere, where they change hands from one set of dealers to another, by whom they are retailed to the cultivators.

Irrigation.

The importance of the part played by irrigation in the agriculture of the Provinces may be judged of by the fact that it is† applied to at least one acre out of every four under crops, and if those crops are excluded which are grown in the rainy seasons, the proportion rises to one in every 2½ acres. This is at the outset somewhat surprising, since the smallest average annual rainfall of any District is 24·51 inches, which would be considered amply sufficient in English farming. But the rainfall instead of being spread throughout the year is almost wholly concentrated in three or four months, and is so capricious in its quality and its distribution, that farming scarcely rises above speculation in great portion of the Provinces, unless provision be made to supplement the rainfall by irrigation. The undoubted increase in irrigation during the British occupation is therefore easily explained, since with the increase of population it became a matter of increasing importance to render harvest prospects as secure as possible.

The monsoon rains which commence about the end of June are, as a rule, over by the beginning of October at latest, and the rabi crops are not sown until a fortnight later than this. Theoretically they should be refreshed by the winter rains, which are due by the end of December, but practically this only occurs in the Western and Sub-Himalayan Districts, and in the centre and south of the Provinces, unless provision be made for irrigating them, they have to make shift from sowing time to harvest on the moisture, which the soil retained after the end of the monsoon. Even during the months when the monsoon rains are at their height long breaks often occur, which are especially harmful to the maize and rice crop, and hence it comes that there is a considerable amount of irrigation in the kharif season if water can be obtained with moderate trouble and expense.

There is a very considerable difference in the average amount of rainfall which is obtained by different parts of the Provinces, and we should *primâ facie* expect to find corresponding differences in the extent of irrigation. But the comparison is complicated by a number of other differences, (those in facility of irrigation and character of crops being the chief,) and the relation between rainfall and irrigation is therefore to some extent obscured. The following figures are derived from the annual agricultural returns of the 30 temporarily settled N.-W. Provinces Districts, being based on the

* The average quality of Sub-Himalayan breeds is poor, but they produce some of the finest cattle in India.—W. C. B.

† Judging from the returns of the 30 N.-W. Provinces temporarily settled Districts for which alone statistics are possessed.

averages of the past three years. The area under sugar-cane and indigo has been excluded from that under kharif crops, since they are both sown during the hot weather, and their irrigation is therefore not dependent on rainfall.

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai only.
Normal rainfall from June to October, ...	31·25	35·73	26·78	31·52	40·49	31·57	35·75
Percentage of kharif area irrigated,	26·5	6·2	12·9	7·3	18·2	1·2	31·1
Normal rainfall from November to May, ...	5·56	4·73	2·55	2·26	3·55	2·06	6·53
Percentage of the rabi area irrigated, ...	41·3	15·3	56·3	25·4	60·8	10·6	30.5

The large amount of irrigation in the Meerut Division as compared with that in Rohilkhand, although the rainfall of both is very nearly the same, is due to the facilities offered by the Ganges and Jumna Canals, and will be noticed further on.

The influence on irrigation of variations in rainfall is of course very marked, irregularities in distribution having, however, much more effect than irregularities in the total annual fall. The following table shows this very clearly. The difference between the area irrigated in 1879-80 and that irrigated in 1880-81 seems disproportionately small when compared with the difference in the rainfall, but whereas in the former year the rain was all concentrated into four months, in the latter it was much more evenly distributed, there being a considerable fall of rain in the cold weather.

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur.	Benares Division, including Basti, Gorakhpur and Azamgarh.	Jhansi Division.	Kumaun Division, including Tarai only.
* Rainfall—	inches.	inches.	inches.	inches.	inches.	inches.	inches.
in 1879-80, ...	46	66	37	31	64	42	70
in 1880-81, ...	39	36	15	14	40	17	32
Irrigated area (in thousands of acres)—							
in 1879-80, ...	14·20	4·48	11·77	6·75	17·82	72	57
in 1880-81, ...	17·52	3·84	15·91	6·98	15·94	71	55

The sources of irrigation may be classified as (1), wells; (2), streams and tanks; and (3), canals. It is noticeable that the most important of these sources are principally replenished by the Himalayan and not the local rainfall. All the principal canals draw their water from Himalayan streams, and it is possible that the water-table from which the wells are supplied is fed more by, so to speak, lateral percolation from the direction of the Himalayas than by downward percolation of the local rainfall.

The average area irrigated from each of these sources in the 30 temporarily settled N.-W. Provinces Districts for which reliable statistics are available is given below :—

* Calculated on the falls at District head quarters.

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur.	Benares Division, including Basti, Gorakhpur and Azamgarh.	Jhansi Division.	Kumaun Division, including Tarai only.	Total of 30 temporarily settled districts of N.-W. Provinces.
1. Total cultivated area,	44,23,250	39,83,423	36,73,436	38,95,806	36,14,244	13,07,559	1,81,915	2,10,79,633
2. Total irrigated area,	14,30,545	4,15,992	11,35,054	6,18,480	15,70,162	65,058	56,807	52,91,598
= per cent. on 1,	32·3	10·4	30·9	*15·9	43·4	4·9	3·0	25·1
from wells, ...	6,64,253	2,18,256	7,46,083	3,68,175	6,94,359	49,611	207	27,40,944
= per cent. on 2,	46·4	52·5	65·7	59·6	44·2	76·2	·4	57·8
from canals, ...	7,28,210	47,503	3,14,334	1,24,510	72	1,132	56,050	12,71,811
= per cent. on 2,	50·9	11·4	27·7	20·1	·0	1·8	99·5	24·0
from other sources,	38,082	1,50,233	74,637	1,25,795	8,75,731	14,315	50	12,78,843
= per cent. on 2,	2·7	36·1	6·6	20·3	55·8	22·0	·1	24·2

The table exhibits some interesting contrasts. As regards facility of obtaining canal irrigation the Meerut and Agra Divisions are about on a par, but in the Meerut Division the areas irrigated from wells and from canals are nearly equal, while in the Agra Division the area irrigated from wells is double that irrigated from canals. This is possibly due in some part to a greater tenacity of the soils in the Agra Division, which makes well construction much easier and more remunerative. Irrigation from streams and tanks is comparatively unimportant except in the Benares Division, where these sources are replenished each year by much heavier monsoon rains than reach the Western Districts.

Wells.

Irrigation wells may be divided into masonry and non-masonry, the former costing from ten to twenty times as much as the latter, but being of course far more efficient and durable. In constructing a masonry well the English system of under-pinning is not practised ; a hole is dug down to the water level, in which the masonry is built up, and the cylinder is then sunk bodily down through the soil until it meets a stratum of sufficient tenacity to bear it. The sinking is effected by excavating the earth from the centre, and heavily weighting the cylinder, and it is evident that this would be only possible in a soft alluvial soil. Should a clay stratum not be met with the well is a failure, since sand will blow up from below as water is drawn from it, and the cylinder therefore go on sinking. The irregularity in the distribution of sub-surface strata has been already noticed, and to commence sinking a masonry well requires therefore a certain amount of enterprise as well as capital. The number of buckets which the well will carry depends on its diameter, and commonly varies from one to four. The cost of the well depends very greatly of course on its depth, but if water be 30 feet below the surface, may be estimated as Rs. 200 for a single bucket, and an extra Rs. 100 for each additional one. Earthen wells are much cheaper, and under favorable circumstances do not cost more than Rs. 10 or Rs. 12.† But their cost and durability depends very greatly on the strata through which they pass. In some places they will last without repair for 10 or 12 years, while in others they need re-excavation each season. In very few cases can one be sunk without passing through at least one layer of sand which is blocked from falling in by a lining, ingeniously constructed of basket-work, grass bands, or wood, which is fixed in the well for the depth through which the sand extends. Where the layers of sand are very numerous or continuous

* Percentage lowered from the inclusion of the Bundelkhand Districts of Banda and Hamirpur, in which there is little or no irrigation.

† In many tracts where the water level is high a hole in the ground which will water a few biswas can be dug for a rupee or even less.—W. C. B.

it is impossible to construct earthen wells, and if there is no clay stratum within a reasonable distance, masonry wells for reasons given above are equally impossible. Unfortunately this state of things is not at all exceptional.

The supply of water in a well varies considerably according as it is drawn from below an impermeable bed of clay or merely from loose water-bearing strata surrounding the bottom and sides of the well. "Spring" wells are, therefore, those which have been sunk down to the clay through which a hole is then bored, while percolation wells end in loose sand. In the first case a plentiful supply of clear water rises from a basin which forms below the clay, while in the second case there being no such reservoir the water drains but slowly into the well, being much impeded by the sand which is mixed with it.

In places where the water table is at a greater depth than 55 and 60 feet from the surface, cultivators do not consider well irrigation profitable, and for this reason wells occur but rarely in the high tracts over-looking river beds.

When the depth to water is more than 12 or 18 feet, the water is lifted by a leather bucket drawn by bullocks, and although this means appears a rude one, yet experiment has shown that it is far from being inefficient. The capacity of the bucket varies between 12 and 25 gallons, and it is suspended by a rope which passes over a wooden pulley fixed above the well mouth, and is secured beyond to the yoke of the bullocks. In order to give the bullocks all the advantages to be derived from dead weight, the run is excavated in the ground, and forms a steep slope down which the bullocks literally hurl themselves, the driver often subscribing his own weight by sitting on the rope. There are considerable differences between the capacity of the bucket, the size and efficiency of the pulley, and the slant of the bullock run, which are often strictly localized, although with no apparent reason. Thus west of Aligarh the pulleys are all neatly made in wheel form and are of large size, while east of Aligarh they are merely rough discs of wood generally far too small for efficiency.

Two systems are used in working the bucket. In one (known as *nagor*) each bucket is worked by a single pair of bullocks, while in the other (called *kíli*) two pairs are employed, one pair drawing the bucket while the other are on their way up to the well mouth. This is effected by the driver detaching the rope from the yoke when the bullocks have arrived at the bottom of the run, and walking up to the well mouth carrying it in his hand while his bullocks turn into a side run made for the purpose, and by which they find their way to the well mouth. The driver arrives there before them, but finds the other pair waiting for him, and by the time these have drawn their load the former pair are in position. Each bucket whether worked by *nagor* or *kíli* requires two men, one to drive the bullocks, and one to empty the bucket at the well mouth. The *kíli* system saves the difference between the time in which the driver walks up to the well mouth and that which the bullocks would take to do it, and the rest which the bullocks obtain after each effort enables them to work nearly two hours a day longer, and that too on a bucket which is larger than could be used with a single pair. Hence the single bucket performs very nearly if not quite as much work as two buckets worked by *nagor*, and the labour of two men is therefore saved.

The strict localization of the two systems is therefore a matter for some surprise. East of Etah hardly a well can be found worked by *kíli*, while west of it one worked by *nagor* is equally rare. There are no differences in soils, depth of water, or quality of cattle sufficiently great to account for this, although undoubtedly the cattle are finer in tracts where the *kíli* system prevails.

The efficiency of the well bucket increases with the depth from which water is raised. At a depth of 20 feet the useful work performed by each bullock is only about ·07 horse-power, while at 35 feet it increases to ·12 horse-power. The area irrigated in a day varies between $\frac{1}{4}$th acre at 20 feet and $\frac{1}{3}$th acre at 40 feet. In parts of Rohilkhand, Oudh and the Benares Divisions, coolies

are sometimes used instead of cattle, when six to eight men are employed on the rope and are considerably more efficient than an average pair of bullocks.

The Persian wheel or Noria (*rahat*), which is commonly used in the Punjab, is only found in these Provinces in two small and very dissimilar tracts, one comprising part of the Jhansi, and the other a part of the Saháranpur District. It consists of a large vertical wheel fixed over the well mouth, carrying an endless rope bearing a series of earthen jars. The wheel is turned by an arrangement similar to the modern "gin," a pair of bullocks turning a horizontal wheel geared by large wooden teeth into the end of the shaft of the vertical wheel. The lower portion of the rope dips into the water, and as the wheel turns each jar is submerged in turn, and is brought up filled with water, which it empties into a wooden trough so soon as it turns the summit. The machine is only used for short depths, and will, with water 20 feet from the surface, irrigate about $\frac{1}{7}$th acre in a day when worked by two bullocks and one man. It costs from Rs. 25 to Rs. 50, but its workmanship is usually of the roughest possible description, and it is very far from yielding the maximum possible amount of work.

The *dhenkli*, or lever lift, consists of a long pole hinged near one end to a pivot between two earthen or wooden pillars, and carrying a rope with an earthen pot at the end of the long arm, and a counterpoise of dry clay at the end of the short arm. The pillars are fixed at a short distance back from the mouth of the well, so that the end of the long arm comes directly over the well when the pot is lowered into the water. Owing to the counterpoise very little exertion is needed in lifting the pot. The lift can only be employed for depths less than 12 or 14 feet, and is chiefly used in the Sub-Himalayan tract and in fluviatile plains where water is near the surface, and wells are mere holes in the sand fed by percolation, which would be completely emptied by a more rapid method of raising water. Its cost is from Re. 1 to Rs. 3, and worked by two men off and on during a day it will irrigate $\frac{1}{8}$th acre from a depth of 10 feet. The feebleness of the lift and of the well which it works is, however, compensated for by number, there being one to every two or three fields, and the long straight poles standing erect, like the masts of shipping, are a very prominent feature in the scenery of a Dhenkli tract. Another lift used under similar circumstances is the *charkhi*, which consists of a wheel bearing a rope with an earthen pot at each end, the rope being worked alternately in each direction, one pot coming up full while the other descends empty.

Tanks and Streams.

Tanks are most extensively used for irrigation in the Benares Division, where the rainfall is heavier and the soil more tenacious than in the Central and Western Districts. Along the southern edge of the Province, and on the border of the Central Indian hill range, there are numbers of magnificent tanks which were constructed by native princes of the Chandel dynasty, but merely as appendages to temples, and not as irrigation works as has been often popularly supposed. Attempts have been made to utilize them as reservoirs for small irrigation canals, but with not very conspicuous success. In the Sub-Himalayan tract irrigation from streams is extensively practised, a dam being thrown across the bed at the end of the rains, and water-courses led off from above it. The rights which different villages situated on the stream have in these temporary irrigation works are settled by custom, the power of damming the stream being often shared by different villages, and exercised by them in rotation one year after another.

The ordinary means of raising water from tanks and rivers, and of lifting canal water when delivered below the surface level, is the swing basket, which consists of a shovel-shaped basket of either bamboo or leather (called *beri* in the former and *bauka* in the latter case), with strings attached to its corners, by means of which the basket is swung backwards and forwards by two men standing one on each side of the hole from which water is to be raised, and almost on a level with the place on which it is to be delivered. At the commencement of each forward swing the basket dips into the

water, and emerges with a load which it deposits at the end of its swing on a raised basin, which forms the end of the distributing channels or one corner of the field to be irrigated. Great dexterity is acquired in the use of this lift, which is worked by movement of the body and wrists, with but little strain on the muscles of the upper arm. Sometimes two are worked at the same lift, one behind the other, the swings being of course carefully kept in time. The depth at which the lift is most efficient is 3½ feet, when three men working turn and turn about can irrigate ⅔ths acre in a day. Five or 5½ feet is the maximum depth to which a single bucket is worked, but occasionally a series of them is employed to lift from depths of 10 or 15 feet, being arranged in steps one above the other. The efficiency of this method of lifting water entirely depends on the labour supply, and it is therefore in most common use in the thickly populated Districts of the Middle and Lower Doáb and the Benares Division.*

Canals.

With the exception of the temporary water-courses of the Tarai and sub-Himalayan tract, all the canals in the Provinces are the property of Government. They may be classified according as they draw their water supply from snow-fed streams, from streams merely fed by rains, or from tanks. In the first class fall the two Jumna and two Ganges Canals, in the second, the Dún and Rohilkhand Canals, and the canals in the Bhábar below the Kumaun hills, and in the third class the Bundelkhand Canals which are at present working. The Sárda Canal, the project of which is still under consideration, will, if made, fall in the first, and the Betwa Canal in the Jhansi Division, now under construction, falls in the second class.

The area irrigated by these canals in the last three years is shown below :—

	Rabi.			Kharif.			Total.		
	1878-79.	1879-80.	1880-81.	1878-79.	1879-80.	1880-81.	1878-79.	1879-80.	1880-81.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Class I.—Snow-fed River Canals.									
From Jumna—									
Eastern Jumna, ...	1,81,228	1,42,201	1,28,408	1,10,722	98,032	1,07,454	2,91,950	2,40,233	2,35,862
Dehli and Agra, ...	83,094	36,286	1,05,378	40,484	20,911	37,027	1,23,578	57,197	1,41,405
From Ganges—									
Upper Ganges, ...	7,25,872	5,57,937	3,59,373	4,83,356	4,01,471	3,05,554	12,09,228	9,59,408	6,64,927
Lower Ganges, ...	6,262	28,896	3,99,501	10,432	10,883	1,83,970	16,694	39,779	5,83,471
Class II.—Rain-fed River Canals.									
Dún Canals, ...	9,607	8,804	6,867	3,597	6,160	6,441	13,204	14,964	13,308
Bijnor Canals, ...	1,281	1,730	2,041	..	656	2,808	1,281	2,386	4,849
Rohilkhand Canals, ...	57,237	66,277	29,985	21,679	18,981	57,644	78,916	85,258	87,629
Bhábar Canals, ...	45,440	45,904	46,300	..	..	..	45,440	45,904	46,300
Class III.—Tank Canals.									
Bundelkhand Canals, ...	1,611	1,351	1,008	188	392	237	1,799	1,743	1,245
Total, ..	11,11,632	8,89,386	10,78,861	6,70,458	5,57,486	7,00,135	17,82,090	14,46,872	17,78,996

These figures show the *cropped* area irrigated, and hence include twice over the area which bears

* Irrigation by *beris* is exceedingly common in Oudh and Rohilkhand.—W. C. B.

two crops in the year. The Table on page xiii preceding only shows the actual area to which water was applied irrespective of the number of crops raised by it, and which is considerably less than that indicated by these figures.

With the exception of the Eastern Jumna, which dates from the time of the Mogul emperors, all these canals have been constructed by the British Government, the most recent being the Agra and Lower Ganges Canals, the former of which was not fully opened until 1878, and the latter not until 1879. The great variations in the area irrigated by the Agra Canal indicate that it has not yet acquired a settled hold of the agriculture of the tract through which it passes. The progress of irrigation on the Lower Ganges Canal is obscured by the transfer to it of a portion of the Upper Ganges Canal, which also accounts for the decrease of irrigation indicated in the returns of the latter.

These canals represent a total outlay of about 6¾ crores* of rupees, and are worked at a total annual expenditure of 19 lakhs of rupees, yielding a net profit of from 4 to 5 per cent. No compulsory water rate is assessed on the villages through which the canal passes, but whoever wishes for the water takes it, his land being subsequently measured up and charged for the water at a rate which varies with the kind of crop grown, ranging between Rs. 6 per acre for sugar-cane and Rs. 3 for wheat or barley. Different crops require different amounts of water, and this method of assessment is therefore to some extent based upon the amount of water used, although a single irrigation renders a cultivator liable for the full amount.

Canal water may reach the cultivator either flush with the surface of the ground, when he has merely to allow it to flow over his field, or at some depth below the surface, when he has to lift it. Regard is paid to this in the canal tariff, "flush" rates being considerably higher than those for "lift," but not in all cases as high as the full value of the difference. The rates per acre are summarized below :—

	Upper Ganges and Eastern Jumna Canals (rates as originally fixed).			Lower Ganges and Agra Canals, (rates as recently revised.)		
Sugar-cane and rice—	Rs.	A.	P.	Rs.	A.	P.
Flush, ...	5	0	0	6	10	8
Lift, ...	3	5	4	3	5	4
Tobacco, opium and vegetables—						
Flush, ...	3	0	0	4	0	0
Lift, ...	2	0	0	2	0	0
All rabi crops, indigo and cotton—						
Flush, ...	2	4	0	3	0	0
Lift, ...	1	8	0	1	8	0
All kharif crops not specified above—						
Flush, ...	1	10	8	2	0	0
Lift, ...	1	10	0	1	0	0

Irrigation has of course a very different value in different parts of the country, but these rates are fixed for the whole Provinces, and afford therefore but little indication of the real value of the water.

* Exclusive of charges on account of interest unpaid in back years, which amounts to 4¼ crores. The total income of the canals has amounted to nearly 3½ crores, so that if no charge is made on account of *compound* interest, the deficit only amounts to a little over eighty thousand rupees.

It must not be imagined, however, that the whole of the area irrigated by canals would be otherwise unirrigated. Unfortunately the earlier made canals were aligned through the most fertile parts of the Provinces, which in general were already abundantly supplied with well irrigation, and in these tracts the effect of the canal in ordinary years has been in great measure merely to supplant one kind of irrigation by another, without directly increasing the productiveness of the country, otherwise than by releasing labour which would otherwise be employed in raising water from wells. To arrive even only approximately at the proportion of the canal irrigated area which would have been irrigated from other sources had the canal not been in existence is a task of extreme difficulty, especially in case of the older canals. The only data which are available are (1), the revenue enhancements made at the last settlement in canal irrigated districts; and (2), the income from the rate now levied from landholders on land which the canal has converted from unirrigated to irrigated since settlement. But irrigation was only one of many considerations which determined the amount by which the revenue of a District was enhanced, and to estimate its proportionate weight as compared with that of improvement in communication, rise in prices, &c., would be difficult if not impossible, especially as the accuracy of the area returns professing to show the extent of irrigation before the construction of canals is open to very great suspicion. In the case of the Agra Canal, however, matters are less complicated, since it was not opened until after conclusion of settlement, and hence all land which is exclusively indebted to the canal for its irrigation is assessed to owner's rate. The collections of owner's rate during 1881-82 indicate that 36,900 acres out of the total area irrigated (1,35,421 acres) would otherwise have been dry, so that the area on which the canal may be presumed to have merely supplanted existing means of irrigation forms as much as 72 per cent. on the total. But the value of canals as a *protection against drought* can be hardly over-estimated, since in a complete failure of rain wells have been proved to be a very far inferior resource.

Cost of irrigation.

It remains to give briefly an indication of the comparative cost of irrigation by the different methods described above, and for this purpose it is presumed that the bullocks used on the well would be kept in any case for ploughing, and the only charge made on account of them is the cost of the extra food which irrigation work would necessitate their receiving. The wages of a labourer are taken as two annas a day, and the labour of the man who distributes the water in the field is not taken into consideration. The field to be irrigated is presumed to be under wheat, and to receive three waterings.

Source of irrigation.	Height to which water lifted.	Area irrigated in one day.	Price paid for water.	Wear and tear of well and implements and interest on capital outlay if any.	Cost of Labour.				Total cost.
					Bullocks.		*Men.*		
					Per day.	Total.	Per day.	Total.	
	feet.	acre.	Rs. A.	Rs. A.	R. A.	R. A.	R. A.	R. A.	Rs. A.
Kacha well worked by lever lift,	10	⅛th	...	0-8	...	...	0-4	6-0	6-8
Kacha well worked by one pair bullocks, ...	30	⅛th	...	2-4	0-3	2-13	0-4	3-12	8-13
Pakka well worked by one pair bullocks, ...	30	⅛th	...	3-4	0-3	2-13	0-4	3-12	9-13
Tank by swing basket, ...	4	¼th	...	...	...	...	0-6	4-8	4-8
Canal by swing basket, ...	3	⅛th	1-8	...	...	...	0-6	3-6	4-14
Canal flush, ...	...	3	3-0	...	...	...	...	...	3-0

The low cost of canal irrigation as compared with other methods is very striking, and yet it appears very doubtful whether the rates would bear much raising. The value of canal water to a cultivator is much lessened by the uncertainty of its supply. Water can only be legally taken during certain periods which are fixed for each village, and should there be a great demand for water higher up the distributary, or the cultivator's field be situated at some distance from the supply channel, it not unfrequently happens that water is only obtainable at very irregular periods. And even with a regular or continuous water supply irrigation can often only be effected at irregular intervals, owing either to the rapacity or caprice of under-officials, who to a great extent control distribution, or to the enmity or requirements of a more powerful neighbour, who is enabled by the position of his fields to engross more than his share of the water allowance. The importance of timely irrigation to crops can be hardly over-estimated, and hence it is no uncommon thing to see cultivators working their wells for the more valuable crops within a stone's throw of a canal distributary, since in the one case, the water supply is certain even if costly, while in the other a sudden failure of water may entail the absolute ruin of the crop. The difference between the cost of canal and that of well water may be taken therefore as the measure of loss which the cultivator considers it possible that he may suffer from the supply not being timed to suit his crops. Of the numerous objections which are from time to time urged against canal irrigation, this appears to be the only one which is founded on a solid basis of truth.

Cost of cultivation.

The average size of farms is so small, ranging from 8·6 acres in the Meerut Division to 3 acres in the Eastern Districts, that a large share of the cultivation is borne by "home" labour—the labour of the cultivator himself, his wife and his children. The actual cash expenditure incurred is therefore generally insignificant, except in those localities where very high farming is practised, and the production of crops such as sugar-cane or potatoes necessitates the employment of a good deal of hired labour. Still, however, it may be said that it is fair to appraise home labour at the rates at which it could obtain remuneration if let out to hire, but under any circumstances it would be difficult, if not impossible, to value the care and attention which an industrious cultivator and his family apply to their land out of hours, and which often serves to extract a profit under circumstances which otherwise would allow of none. The amount of this extra labour varies of course with the interest of the tenant in his land, and reaches its maximum in the case of those who have acquired under the law a right of occupancy at a fair rent. No allowance for extra labour is made in the following calculations, which show the cost of each operation if labour be valued at rates prevailing in the Cawnpore District, which are rather higher than those of most other parts of the Provinces. These calculations form the *data* on which the cost of cultivation given under the head of each crop is deduced.

Operation.	Cost per acre each time practised.	Remarks.
Ploughing, ...	-/12/-	A pair of plough bullocks with ploughman can be hired for Re. 0-8-0, and will plough an acre in a day and a half.
Harrowing (or clod crushing), ...	-/2/-	
Seed, ...	variable.	
Sowing, ...	-/13/- or -/14/-	If sown broad-cast Re. 0-13-0, if drilled Re. 0-14-0.
Weeding, ...	-/12/- to 1/8/-	Re. 1-8-0 for kharif weeding, Re. 0-12-0 for rabi.
Watching, ...	-/12/-	For kharif crops only. Two watchers for 20 days at Re. 0-1-6 each per diem will watch, day and night, 5 acres.

Operation.	Cost per acre each time practised.	Remarks.
Reaping, ...	varies.	
Threshing, ...	3/-/-	Assuming produce to be 20 maunds grain. One pair bullocks (at 3 annas) and one man (at 2 annas) will thresh out 168 lbs. in a day of eight hours.
Cleaning, ...	-/6/-	Assuming produce to be 20 maunds grain.
Watering—		
Canal dues, ...	variable.	Irrigation is assumed to be with canal water, and by a lift of 4½ feet.
Labour of lifting, ...	1/2/-	
Labour of distributing, ...	-/2/-	
Labour of making water beds (once in a season only), ...	-/3/-	
Manure, ...	3/- per 100 maunds.	Manure is not ordinarily sold, but will as a rule command this price if in the market.

Average outturn.

The figures which profess to show the average outturn of each crop are very far from being absolutely reliable. The striking of an average for the outturn of agricultural produce is a task of considerable difficulty, even in countries where tolerably full information is possessed, and Government can obtain willing assistance from private agriculturists. In India the difficulty is one that can hardly at present be surmounted. To the uncertainty which arises from ignorance, and from a greater diversity of conditions than occurs in European or American agriculture, there is superadded the error which results from wilful mis-statement, centuries of oppression having taught the Indian cultivator that he is likely to benefit more from the ignorance than from the enlightenment of his rulers. To these causes must be ascribed a divergence of authority that would otherwise seem ridiculous. Three sub-divisions of the Saháranpur District, for instance, are represented as enjoying such widely different outturns of wheat as 12 maunds, 18½ maunds, and 24 maunds, respectively.

It has been considered advisable, therefore, rather to found the estimates of average outturn on a few selected authorities than to attempt to find a mean between a large number of conflicting opinions, and amongst the authorities on whom greatest reliance has been placed may be mentioned the Bareilly and Azamgarh Settlement Reports, by Messrs. Moens and Reid, and Mr. Wright's Memo. on the Agriculture of the Cawnpore District. Any lessons taught by the results of experimental farming on the part of Government in these Provinces have also been carefully borne in mind. It will be noticed that in many cases the averages which are assumed are considerably higher than those in ordinary acceptance with Government officials, but there are few things so certain as that the outturn obtained by Indian cultivators is very generally under-estimated, and there even have not been wanting statisticians who have succeeded in demonstrating that the greater part of Indian farming is carried on at a considerable annual loss to the cultivator and the country. The lowness of current estimates is partly due (as has been mentioned above) to wilful under-statement by landholders and cultivators, who are slow to see in the curiosity of Government any object other than an increase of taxation, and partly perhaps to statistical difficulties experienced by Settlement officers desirous of maintaining what is considered the proper ratio between rent and produce. With the increase of population and diminution in the size of holdings, the produce per acre rises very greatly. Rents rise at the same time, but not by any means *pari passu*, and the proportion between rent and produce has a tendency

therefore to decrease. In backward parts of the Provinces where farms are large and cultivation low, rents are generally paid in kind, often amounting to half, and very seldom to less than a third, of the produce; the produce, however, being so small as not to make the landlord's share worth more than Re. 1 or Rs. 2 per acre. Smaller farms necessitate a larger produce, but the increase is obtained at an expenditure which will not admit of a proportionate increase in rent. In such cases rent may be as high as Rs. 10 per acre, and still not represent more than $\frac{1}{10}$th of the gross produce. It has, however, been customary to regard rent as measured with more or less exactness by $\frac{1}{3}$rd of the produce, and this principle has been not unfrequently reconciled with facts by understating the produce when the rent seemed unduly low.

The distribution of the rabi, kharif, and total cropped area amongst the more important crops in the 30 temporarily settled N.-W. Provinces Districts is shown below in the form of a percentage. The figures have been calculated from an average for three years—1878-79, 1879-80, and 1880-81.

Crop.	Percentage on			Crop.	Percentage on		
	Kharif area.	Rabi and *zaid* area.	Total area.		Kharif area.	Rabi and *zaid* area.	Total area.
Kharif.				*Rabi.*			
Juár, ...	10·7	...	5·7	Wheat, ...	...	28 6	13·4
Bájra, ...	7·7	...	4·1	Wheat and Barley, ...	...	9·5	4·2
Arhar, ...	1·0	...	0·5	Wheat and Gram, ...	...	8·1	3·8
Juár and Arhar, ...	12·1	...	6·4	Barley, ...	...	13·5	6·3
Bájra and Arhar, ...	7·7	...	4·1	Barley and Gram, ...	...	19·2	9·5
Maize, ...	5·7	...	3·0	Gram, ...	...	10·3	4·8
Rice, ...	21·3	...	11·3	Peas, ...	...	3·3	1·5
Urd, ...	2·0	...	1·0	Masur, ...	...	1·0	0·4
Moth, ...	1·6	...	0·9	Potatoes, ...	...	0·1	0·1
Cotton, ...	4·1	...	2·2	Opium, ...	...	1·3	0·6
Cotton and Arhar, ...	6·9	...	3·6	Tobacco, ...	...	0·2	0·1
Sugar-cane, ...	4·8	...	2·5	Melons, ...	...	0·2	0·1
Indigo, ...	2·0	...	1·1	Vegetables, ...	...	0·1	0·0
Fodder crops, ...	2·6	...	1·3	Garden food crops, ...	...	0·1	0·0
Garden food crops, ...	0·1	...	0·1	Garden non-food crops, ...	...	0·2	0·1
Garden non-food crops, ...	0·1	...	0·1	Miscellaneous food crops, ...	...	1·3	0·6
Miscellaneous food crops, ...	7·8	...	4·1	Miscellaneous non-food crops,	...	3·0	1·5
Miscellaneous non-food crops,	1·8	...	1·0				

J. B. FULLER.

FIELD AND GARDEN CROPS

OF THE

NORTH-WEST PROVINCES AND OUDH.

PART I.

TRITICUM SATIVUM, *Lam.*

[*Vide* Plates Ia. and Ib.]

*ENGLISH, wheat; VERNACULAR, gehun, gohun, gandum (Persian).

Description.

Natural order *Gramineæ*, tribe *Hordeeæ*. An annual herbaceous grass. Stems many, 2-3 ft. high, erect cylindrical, jointed, hollow except at the swollen pubescent joints, smooth, striate, glaucous. Leaves few, distant; sheaths long, not inflated, smooth above, usually hairy on the lower surface; ligule short, truncate, torn; blade 6 in. to 1 ft. or more in length, linear, gradually tapering to a point, smooth or with a few scattered hairs, ciliate at the base, glaucous green. Spikelets 3-5-flowered, (the terminal flower always barren,) sessile, compressed, distichously arranged on the two sides of a flattened excavated hairy rachis, the whole forming an oblong linear cylindrical or sub-quadrangular spike 3-5 in. long, and with a few abortive spikelets at the base. Glumes 2, equal, boat-shaped, oblong-oval, hard, smooth and polished, midrib extended into a sharp point with forward prickles. Pales 2, about equal in length, the lower boat-shaped, obtuse mucronate or awned, the upper thin, papery, transparent, with two lateral nerves, edges inflexed, ciliate. Lodicules 2, hairy at the top. Stamens 3; filaments slender; anthers large protuded at the time of flowering. Ovary obovate, truncate, hairy at the top; stigmas 2, nearly sessile, feathery. Fruit (the grain) enclosed within but not adhering to the pales, about $\frac{1}{6}$ in. in length, ovoid or roundish, flattened on the ventral side and with a deep longitudinal groove, white yellow or reddish. Embryo minute, on one side at the base of hard floury albumen.

Varieties.

The countless varieties and sub-varieties of wheat which are grown in these Provinces speak volumes for the importance of the part which it plays in the agriculture of the country. It is only with rice that we find anything like the differentiation which years of natural and artificial selection have produced in wheat. It would be futile to attempt to classify these varieties by the vernacular names which they bear, since these names are in most cases of very local application, and even when used over an extensive tract of country are often found to be applied to totally different varieties in different parts of it. All that is possible here will be to indicate the lines on which the varieties may be most rationally classified, noting the vernacular names of a few of the most prominent ones.

The most convenient primary sub-division of wheats is into starchy and glutinous or soft and hard, the former containing a larger proportion than the average of starch,

* References:—Lam. Encycl. Meth. ii. 554. Bentley and Trimen Medicinal Plants 294. *T. vulgare*, Vill; Powell Punj. Prod. 225; Drury Useful Pl. 434. *T. æstivum*, Roxb. Fl. Ind. i. 359. *T. hibernum*, Roxb. l. c.

and being thus especially fit for the production of fine flour (*maida*), while in the wheats of the latter class gluten predominates, rendering the grain especially productive of semolina (*suji*). Grains of the first class break easily, with an opaque pure white fracture, whilst those of the second class are difficult to break or bite, and appear more or less translucent. Soft wheats are in most demand for the English market, but hard wheats command a market in Mediterranean ports for the production of maccaroni, and are preferred by the Natives of the country as the more wholesome for general consumption. Each of these classes may be sub-divided into two sub-classes distinguished by the grain being white or red, and the varieties included in each of these sub-classes may be further grouped according as the ear of the plant is or is not furnished with awns or "bearded." To mention some of the vernacular names which are of most general application, *daudi* or *dudia* is the name of the variety which stands at the head of the list of soft white wheats, and which has been pronounced by English* experts to be equal in value to the finest wheats in the English market. *Mundia* or *murilia* (lit. shaved) is the term applied to beardless wheats; generally white, but not so markedly so as the *daudi*. Hard white wheats are called *badha* in the western portions of the Provinces. *Pissi* generally denotes a soft red wheat, and *kathia* or *lallia* a hard red wheat. *Gangajali* (a common term in the Bombay market) is applied to many different varieties, and its only general application appears to be mixed red and white hard wheats. A curious round berried variety, which somewhat resembles pearl barley, is called *paighambari*, and was apparently an introduction from Arabia.

Distribution.

Wheat is grown to a larger extent than any other crop. The area under either wheat or mixtures in which wheat has a place, amounts in the whole of the N.-W. Provinces and Oudh to some 72 lakhs of acres, 51¾ lakhs of which are in the 30 temporarily settled N.-W. Provinces Districts, constituting 46 per cent. of their total cropped area, and 21 per cent. of the area under rabi crops. The cultivation of wheat grown alone reaches its maximum in the Meerut and Rohilkhand Divisions, where winter rains may be safely reckoned upon, and it is in these Divisions that the finest varieties have their home. In the drier Districts of the Agra and Allahabad Divisions and Bundelkhand wheat is rarely grown by itself, and is generally sown with either barley or gram, which by their superior hardiness continue to eke out a crop in cases where the wheat would fail from insufficient moisture.

This is clearly shown in the subjoined table:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Percentage to total rabi cropped area of							
Wheat alone, ...	43·5	47·8	26·7	9·2	15·0	11·8	58·4
Wheat in mixture,	12·7	14·2	12·2	22·1	14·9	60·8	8·2
Total, ...	56·2	62·0	38·9	31·3	29·9	72·6	66·6

* *See* Dr. Forbes Watson's report on wheat samples collected by the Indian Government and forwarded to the India Office in 1878.

Season.

Wheat is a rabi crop, being sown in the end of October or beginning of November and cut in March and April. As a rule it is only sown on land which has lain fallow during the preceding kharif (called *chaumás* or *púral*), but in highly manured land near village sites it occasionally follows maize, the maize being cut only 6 or 8 weeks at the most before the wheat is sown. No particular rotation is known to be followed, but in tracts where cotton is widely grown, wheat is generally said to follow it, probably, however, merely because cotton in the kharif, like wheat in the rabi, is the crop which is principally grown on the best land of the village.

Mixtures.

Wheat is commonly sown mixed with barley (when it is termed *gojai*), or with gram (*gochana*), as well as grown alone. Averages struck on the crop returns of the 30 temporarily settled districts for the years 1879, 1880 and 1881, shows the area under wheat, wheat-barley and wheat-gram to stand in the relation of the figures 32, 10 and 9. Wheat-gram (also called *birra*) is but little grown north of the Jumna, but in Bundelkhand it forms one of the principal and most characteristic crops. Usually a wheat field contains some rape or mustard sown either in parallel lines across the field or as a border. These flower in the beginning of February before the wheat has begun to ripen, and the contrast of the bright yellow bands with the shining green of their setting is a feature of striking beauty in an Indian village landscape. Linseed and *duán* (*Eruca sativa*) are less commonly sown in wheat fields.

Soils and manure.

Wheat is grown on almost every soil but the very lightest sand; a rather heavy loam being considered best suited to it. The fields of loamy soil (*domat*) which cover a large portion of the Doáb, even when mere isolated *tesseræ* in the midst of usar plains, bear with careful cultivation crops of wheat of surprising excellence, although unmanured for years. But manure is, as a rule, applied to the better class of wheat fields generally in every second or third year, although in quantities which would sound ridiculously small to the English farmer, 4 tons (= 100 maunds nearly) being about the average. It is reported from some Districts of the Provinces (Bijnor, Fatehpur and Gorakhpur) that land is occasionally prepared for wheat by herding sheep or cattle on it, but this is a practice of very far from general occurrence.

Tillage.

The number of ploughings varies within very wide limits, depending not only on the character of the locality and soil, but on the energy and leisure of the cultivator. Thus 20 ploughings are reported as not uncommon in Gorakhpur, while two or three are held sufficient in the black soil of Bundelkhand. Eight ploughings may be taken as the average number. It is essential that the land should be ploughed at the very commencement of the rains, so as to lie in open furrow and drink in the whole of the rain which falls. Indeed the ploughing of wheat land is often held to take precedence of preparations for the kharif crops as is expressed in the proverb

> "Age gohun, pichhe dhán,
> Usko kahiye bara kisán."

The clods are crushed and a fine tilth (which is absolutely essential in most soils) created by dragging a flat log of wood (*mai*, *pátha* or *henga*) across the field, the bullock driver standing on it to increase the weight.

Sowing.

If the ground is very damp the seed is sometimes sown broad-cast and ploughed in, when it is not buried more than one inch below the surface, and is less likely to rot than

if buried deeply. But the two commonest methods of sowing are (1), by simply following the plough and dropping the seed into the furrow made by it, the seed being covered by the earth thrown up by the next furrow, and (2), by dropping the seed down a bamboo fastened to the plough stilt. It is said that the advantage of each practice varies with the condition of the soil, the former being best when the soil is very moist, and the latter when the soil has somewhat dried. But as a matter of fact the practices are strictly localized to tracts within which either one or the other is exclusively followed. The amount of seed used per acre varies from 100 to 140 lbs. After the sowing is completed the field is either left in furrow, or is smoothed with the clod crusher, the latter practice being said to save irrigation by enabling the water to spread quicker over the surface. The field is then divided off into irrigation beds by scraping up little banks of earth with a wooden shovel.

Irrigation.

If the soil is sufficiently moist in October to allow of the seeds germinating properly, the necessity of irrigation depends in chief measure on the occurrence of winter rains. This is shown in the following table, in which the normal winter rainfall of each Division is contrasted with the percentage which irrigated wheat (grown alone) bears to the total:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Normal rainfall between November 1st and May 31st,*	5·56	4·73	2·55	2·26	3·55	2·06	6·53
Percentage of irrigated wheat to total, ...	53·1	20·1	74·3	63·7	71·0	27·4	32·7

The high percentage of the Meerut Division is due to unusual facilities for irrigation from canals. The percentage of the Allahabad Division would have been far higher did it not include the two Bundelkhand Districts of Banda and Hamirpur, where irrigation is rendered needless, as well as impossible, by the character of the soil.

Should the soil be too dry for germination, a watering (called *paleo*) must be given before sowing, and this—a comparatively easy matter in Canal Districts—occasions great labour and delay in Districts which rely on wells for their water supply. The instance of Rae Bareli in the rabi season of 1879-80 shows, however, that nearly the whole of the usual crop area of a District can be sown entirely on well water, should the natural moisture be insufficient as it was in that year. The number of waterings given to wheat varies from one in Rohilkhand to seven or eight in the drier parts of the Doáb, but as a rule three or four waterings are ample even in the driest localities, and when more water than this is used, it is probably merely a cover for bad cultivation, a state of things common enough in Canal Districts, where water is charged for by the crop and not by the amount used. Careful cultivators some times give their fields a weeding after the first

* Calculated from the normal rainfall at each District head-quarters in the Divisions.

watering, and benefit their crops almost as much by loosening the caked surface soil as by removing the weeds, but this is by no means a common practice, and if the land was in clean condition when sown, it is not as a rule weeded. The custom is reported from the Bahraich District, and may prevail in other parts of the Provinces, of topping wheat which shows an undue tendency to run to leaf and stalk, by cutting down the upper portion of the plants with a sickle. This is done when the crop is about 3 feet high, and care is taken not to cut down so low as to damage the ears which have formed in the leaf covers, but not yet emerged. A similar custom obtains in parts of the Punjab where however the young plant is fed down by sheep.

Harvesting.

The crop when ripe is cut by sickles and carried to the threshing floor, where after having been allowed to dry for several days it is trodden out by bullocks, and winnowed by the simple expedient of exposing the grain and chaff to the wind by pouring them out of a basket held some 5 feet from the ground. Should there be no wind, an artificial breeze is made by agitating a cloth, but this adds greatly to the expense and trouble, and is in no way an efficient substitute for the English winnower.

Diseases and injuries.

Indian like English wheat suffers from the attacks of microscopic fungi, but not to the same extent, owing doubtless to the greater dryness of the climate.

There is, however, a considerable difference in this respect between one locality and another. In the Meerut and Rohilkhand Divisions, where winter rains are of regular occurrence and dense mists often prevail in December and January, it would be difficult to find a wheat field in which some plants were not attacked by rust, and occasionally considerable damage is suffered from it, while in the centre and south of the Provinces it often requires a considerable amount of searching in order to discover such specimens. The commonest of the fungous diseases to which wheat is liable is the one known as *rattua* or *girwi*, which appears to be identical with the English mildew or rust. The plant tissues become filled with minute orange coloured spores which, when ripe, burst through the plant skin in longitudinal fissures, sprinkling the leaves and ears with a reddish powder. In this condition it is known to botanists under the generic name of Trichobasis, from the fact that each spore is furnished with a short hair-like protrusion or stalk. As the plant ripens clusters of minute bodies appear, each consisting of a stalk fixed in the leaf tissues bearing a double-celled head. These bodies grow out in clusters, each cluster appearing to the naked eye a minute black spot. In this stage the fungus is known as Puccinia, and was long supposed to be a separate plant from the Trichobasis, instead of merely a stage in its history.

When ears of wheat are distorted and thickly covered with a dark brown or black dust, the plant is infected with the disease known to English farmers as 'smut' (Ustilago), and to natives as *kandwa*. The dust is composed of very minute globular spores far smaller than those of Trichobasis, but resembling them in being single celled. *Rust* does not necessarily altogether destroy the produce, although it almost invariably deteriorates it, but nothing survives the attacks of *smut*. The name *kandwa* is applied to a totally distinct disease in the case of the millets, when it denotes the fungus, known as "bunt" or "ergot" in England, which fills the grain with a greasy black powder, leaving the plant, and indeed the grain itself, externally perfectly healthy looking. Bunt does not appear to be so common in wheat in this country as in England.

The disease known as *lakhua* (Polycystis) consists of spores which fill the plant tissues and break out when ripe in longitudinal fissures exactly like rust, from which, however, it differs in each spore, being a spherical agglomeration of numerous cells (somewhat resembling a blackberry in shape) instead of being unicellular. *Lakhua* is said altogether to prevent a plant from bearing ears.

But by far the most extraordinary disease to which wheat is liable is that known as *sehwan*, in which the young wheat grains are found to be filled with minute worms in various stages of development, comparatively large sized, (apparently) males and females being associated with a mass of oval shaped eggs, from which smaller and less highly organized worms emerge. As the grain ripens at harvest time these worms will be found to have completely filled the grain, having entirely ousted (and possibly eaten) the males, females and egg cases to which they owe their origin. The grain is much shrivelled and of a dark colour, and can be easily recognized as infected. The most extraordinary fact connected with this disease is, however, that the worms can retain their vitality for a very long time, although unprovided with any source of nutriment, and if an infected grain is examined a year after harvest, they will be found matted together in an entangled mass, apparently torpid, but showing no signs of death or decay. This would seem to indicate that their life in the wheat grain is only one chapter of their history.†

Cost of cultivation.

Appraising the whole of the labour applied to the field, the following may be accepted as a near estimate of the cost of growing and harvesting an acre of wheat:—

				Rs.	A.	P.
Ploughing (eight times),			...	6	0	0
Clod crushing (four times),			...	0	8	0
Seed (100 lbs.),			...	3	0	0
Sowing,			...	0	14	0
Weeding,			...	0	12	0
Reaping,			...	1	8	0
Threshing, Cleaning, } on a crop of 20 maunds (= 27 bushels),			...	*3	0	0
			...	0	6	0
Total excluding irrigation, manure and rent,			...	16	0	0
Irrigation (three times)—						
Making water beds,		0 3 0				
Canal dues,		1 8 0				
Labour,		3 12 0		5	7	0
Manure (100 maunds),			...	3	0	0
Rent (for second class land),			...	7	0	0
Grand Total,			...	31	7	0

Average outturn.

The diversity of the conditions under which wheat is grown renders the framing of an average outturn a task of great difficulty. In a report on the wheat cultivation of the Provinces drawn up for the Secretary of State in 1878, the general average outturn was assumed to be 700 lbs., but there seems good ground for believing that this is

* Two pairs of bullocks (at 3 annas a pair) and 2 coolies (at 2 annas each) tread out nearly 340 lbs. grain in a day.

† Since the above was written the worms have been identified as belonging to the order *Nematoidea*, and are apparently of the genus *Tylenchus*. They issue from the infected grain when sown, and attack the growing corn, gaining admission into the flowers, when as yet undeveloped, preventing the development of the grain and producing in its place a green gall (mistaken for the grain above) in which they reside.

far too low an estimate. After collation of the most trustworthy authorities, the lowest average which can be assumed for irrigated land appears to be 15 maunds per acre for wheat grown alone and for wheat-barley, and 13 maunds for wheat-gram. With like advantages the outturn of wheat-barley would be heavier than that of wheat alone, but this is counterbalanced by the general inferiority of the soils on which it is grown, so that the same rate of outturn has been assumed for both. The outturn of wheat-gram is lessened by the yield of gram being less than that of either wheat or barley. The outturn of unirrigated land depends so greatly on the winter rains, and in these the different parts of the Provinces share so unequally, that it will be safer to frame an estimate for each Division separately, than a single one for the whole Provinces.

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division.	Benares Division.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
Wheat alone, ...	10	10	7	7	8	6	8	9
Wheat-barley, ...	10	10	7	7	8	6	8	9
Wheat-gram, ...	9	9	6	7	8	7	8	8

It may be accepted as a general rule that wheat constitutes $\frac{2}{3}$ths of the outturn of wheat-barley and $\frac{2}{3}$rds of that of wheat-gram, except in the Allahabad and Jhansi Divisions, where gram is the principal crop in the mixture, and the proportion of wheat is not much above $\frac{1}{3}$rd.

The outturn of straw varies in weight between half as much again and twice as much as that of grain. When crushed into small pieces, as it is in the process of treading out the grain, it forms perhaps the most important cattle fodder in the Provinces.*

Area. Special returns of the area under wheat in the year 1876-77 were called for from all Districts of the N.-W. Provinces and Oudh, and were compiled in the wheat report alluded to in the preceding paragraph. They showed the total area under wheat in the Provinces to be over 6 million acres, towards which Oudh contributed very nearly a third. No details were given, however, of irrigation, and it is uncertain how far the area under mixed wheat crops was included.

Below is shown the average area under wheat in the 30 temporarily settled Districts of the Provinces, calculated on the statistics for three years, 1879, 1880, and 1881.

* In case it may be thought that an estimate so much higher than those which have generally been accepted requires special justification, the following two authorities may be cited. *1st*, Mr. Moens, when Settlement Officer of Bareilly, after a very large number of experiments extending over several years, deduced a district average of 975 lbs., or nearly 12 maunds, *taking into consideration unirrigated as well as irrigated land*. *2nd*, On the Cawnpore Farm in 1880, 13 irrigated fields, *none of which were watered more than twice*, yielded an average of 1,402 lbs. (= 17 maunds), and 10 unirrigated fields an average of 635 lbs. (= nearly 8 maunds). The smallest outturn obtained from unirrigated land was 500 lbs. During the following season 17 irrigated fields yielded an average of 15 maunds.

Only a small proportion of the Farm land was manured in either season, and the fields on which the averages are based were mostly cultivated with the express purpose of arriving at the average outturn of wheat land under ordinary circumstances. In 1880, the winter rains amounted to only a nominal quantity, and in 1881 to 2·2 inches.

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total 30 temporarily settled Districts.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Wheat.								
Irrigated, ...	5,95,217	2,02,345	3,75,963	1,17,793	2,15,306	17,959	11,808	15,35,891
Unirrigated, ...	5,27,112	8,09,330	1,30,380	67,127	88,198	47,628	23,309	16,93,084
Total, ...	11,22,329	10,11,675	5,06,343	1,84,920	3,03,504	65,587	34,617	32,28,975
Wheat-barley.								
Irrigated, ...	60,962	27,120	83,146	32,045	1,93,887	19,160	1,106	4,17,426
Unirrigated, ...	1,29,836	2,43,766	72,694	46,841	1,05,290	3,671	3,369	6,05,467
Total, ...	1,90,798	2,70,886	1,55,840	78,886	2,99,177	22,831	4,475	10,22,893
Wheat-gram.								
Irrigated, ...	43,089	3,144	40,824	12,465	700	4,359	4	1,04,585
Unirrigated, ...	95,219	26,808	35,985	3,50,933	525	3,10,665	410	8,20,545
Total, ...	1,38,308	29,952	76,809	3,63,398	1,225	3,15,024	414	9,25,130
Grand Total, ...	14,51,435	13,12,513	7,88,992	6,27,204	6,03,906	4,03,442	39,506	51,76,998

The large area under wheat-gram in the Allahabad Division is due to that Division including the two Bundelkhand Districts of Banda and Hamirpur.

The net exports of wheat by rail during the three years 1878 to 1881 are shown below—

Trade.

	Maunds.			Rupees.		
	1878-79	1879-80	1880-81	1878-79	1879-80	1880-81
To Calcutta, ...	11,31,014	13,61,233	15,43,379	33,93,042	37,22,121	32,91,257
„ Other places, ...	19,34,092	15,61,340	11,95,947	58,02,276	43,70,831	25,00,789
Total, ...	30,65,106	29,22,573	27,39,326	91,95,318	80,92,952	57,92,046

Explanation of Plate Ia.

1. Entire plant (¼ nat. size).
2. Portion of stem with leaf. } nat. size.
3. Spike in flower.
4. Spikelet. }
5. Single flower. } enlarged.
6. Ditto without the palea. }
7. Mature spike. } nat. size.
8. Grain. }
9. Ditto.
10. Dorsal view of ditto. } enlarged.
11. Transverse section of ditto. }

Explanation of Plate Ib.

1—5. As in Plate Ia.

6. Mature spike (nat. size).

TRITICUM SATIVUM, LAM.

Drawn by H. Hormuzji

Lithg. T. C. Press, Roorkee.
Thos. D. Bona, Supdt.

TRITICUM SATIVUM, LAM.

Drawn by H. Hormusji

Litho. T. C. Press, Rootkee.
Thos. D. Bona, *Supdt.*

HORDEUM VULGARE, *Linn.*

[*Vide* Plate II.]

ENGLISH, barley; VERNACULAR, jau.

Description.

An annual herb belonging to the tribe *Hordeeæ* of the natural order *Gramineæ*. Stems many, quite smooth, 2-3 ft. high. Leaves few, the upper one close to the spike; sheaths smooth, striate; ligule very short; blade of leaf linear lanceolate, rounded at the base, tapering gradually to the apex, glaucous green. Spikes linear oblong, compressed, 2-2½ in. long (without the awns); spikelets sessile, arranged in threes on two sides of a flattened rachis, lateral ones occasionally barren and rudimentary (var. *distichon*); glumes 2, small, setaceous, and awn-like, enclosing the three spikelets; pales 2, lower one firm, 5-ribbed, rounded on the back and ending in a long stiff awn rough with forward prickles; lower pale a little smaller than the upper, bifid, 2-veined, and with the margins inflexed. Lodicules 2, entire, hairy. Stamens 3, exserted. Ovary hairy on the top. Stigmas 2, feathery. Fruit (the grain) usually with the pales adherent to it.

Varieties.

The different varieties of barley may be broadly grouped according as the ears contain two rows or six rows of grain. The six-rowed variety (*Hordeum hexastichon*) is the one ordinarily grown in this country, bearing grains in sets of threes, alternately disposed on each side of the rachis or flower stalk. It may be easily distinguished from wheat, to the bearded variety of which it bears a superficial resemblance, by the glumes or scales which surround each set of three grains being reduced to thin hair-like appendages, instead of forming a broad covering as is the case with wheat. The two-rowed variety (*Hordeum distichon*) is commonly cultivated in England, but rare in this country. There is a curious sub-variety of two-rowed barley in which the flower scales do not adhere to the grains, forming a continuous covering as with ordinary barley, but drop off in threshing, leaving the grains naked like those of wheat. This sub-variety is botanically known as *Hordeum gymnodistichon*, and bears the vernacular names of *paighambari* or *rasuli*, indicating apparently its introduction from Arabia. It is reported as grown largely in the hills near Kotgarh, but is rare in the plains. A field of it on the Cawnpore Farm in 1879 yielded, with manure and irrigation in moderate quantity, 21½ maunds of grain to the acre.

Distribution.

The total area under barley and mixtures, in which it has a place, in the 30 temporarily settled N.-W. Provinces Districts, amounts to 47¼ lakhs of acres, which is about 20 per cent. of their total cropped area, and 42 per cent. of the total area under rabi crops. It forms an important crop in every portion of the Provinces, being most commonly grown alone in the Districts of the Benares Division; mixed with wheat, in Rohilkhand, and mixed with gram, in Agra and Allahabad.

Seasons.

Barley is a rabi or spring crop, being sown in October and reaped in March or April. It is the crop most commonly grown on land which was cropped in the preced-

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* References:—Linn. Sp. Pl. Ed. I. 84; Powell Punj. Prod. 228; Bentley and Trimen Med. Pl. 293; *H. hexastichon*, Linn. *H. distichon*, Linn. *H. cæleste*, Viborg (beardless barley).

ing kharif season, especially if this crop was unmanured. Hence barley or barley-gram (*bejhra*) is the usual rabi accompaniment of indigo in the kharif, being held better able than wheat to provide itself with nourishment from a soil which has not been allowed to recuperate itself by even a six months' fallow.

Mixtures.

It is less frequently grown alone than sown mixed with either gram and peas (when it is termed *bejhra*) or with wheat (*gojai*), and the area under barley alone, barley-gram and barley-wheat stands in about the relative proportion of 15, 22 and 10. Rape (*Brassica campestris*), mustard (*Brassica juncea*), and the small oilseed known as *duán* or *tara* (*Eruca sativa*), are commonly sown in barley fields either in parallel lines some 15 feet apart or as a border. *Duán* is especially common in unirrigated fields. Linseed is also occasionally grown as a border.

Soils and manuring.

The soils on which barley is principally grown are light and sandy, and, as a rule, are not highly manured. The character of its cultivation depends in great measure on the second crop with which it is associated. If this crop be wheat, the conditions of cultivation may be considered as similar to those of wheat, but if it be gram or peas, the mixture is generally grown on the outlying fields of a village where manure and irrigation (except in Canal Districts) are but sparsely applied. This mixture is the typical rabi crop for unirrigated light land throughout the Provinces.

Tillage and sowing.

The methods of ploughing and sowing are similar to those followed for wheat. The number of ploughings is largest in Rohilkhand (where it is reported to be often as high as 12), and smallest in Bundelkhand where two or three are held sufficient. As a rule, barley does not require its seed-bed so finely pulverized as is necessary for wheat, and is satisfied therefore with a less number of ploughings. Taking the Provinces as a whole, probably four ploughings before sowing will be a safe average. Sowing takes place in October, a little later than for gram, but earlier than for wheat, and is, as a rule, effected by dropping the seed behind the plough either direct from the hand or down a bamboo tube fastened to the plough stilt. The amount of seed sown per acre is from 100 to 120 lbs. Should the September rains have failed, and the ground be too dry for proper germination, the land is, if possible, watered and ploughed before being sown, but this seldom occurs to barley fields, since the efforts of cultivators at such a season are mostly concentrated on their wheat.

Irrigation.

Irrigation when given at all is generally lighter than with wheat, and one or two waterings are, as a rule, held sufficient. In Districts which enjoy a tolerable certainty of winter rains, such as those of the Meerut and Rohilkhand Divisions, it is but rarely irrigated at all. From the Table given further on, it will be seen that the irrigated area comprises about half of that under barley alone, and ⅔ths of that under barley-wheat and barley-gram.

Weeding.

Barley fields are very seldom weeded, nor is the practice of topping an over-leafy crop, which is said to be common in the Punjab, reported from any District of these Provinces.

Harvesting.

Cutting, threshing and cleaning are conducted exactly as in the case of wheat.

Diseases and injuries.

The most striking of the diseases to which barley is liable is that commonly known as *kandwa*, which is the result of the attack of a fungus closely allied to that which causes "smut" in English corn-fields. The first symptoms of the disease is distortion

of the ear and swelling out of the stalk joints. Then a blackish dust makes its appearance on the ear and at the stalk joints, which rapidly spreads over them and entirely destroys the grain. There are very few barley fields in which some of these distorted charred-looking heads cannot be detected, and they are especially numerous in seasons of good winter rain.

Cost of cultivation.

The cost of growing an acre of barley by hired labour may be estimated as follows:—

				RS.	AS.	P.
Ploughing (four times),				3	0	0
Clod crushing (four times),				0	8	0
Seed (120 lbs.),				2	8	0
Sowing,				0	14	0
Reaping,				1	8	0
Threshing,				3	0	0
Cleaning,				0	6	0
Total,				11	12	0
Irrigation (twice)—						
Canal dues,	1	8	0			
Labour,	2	8	0	4	0	0
Rent,				5	0	0
Grand Total,				20	12	0

Average outturn.

Under similar conditions the outturn of barley is from a quarter to a half as much again as that of wheat. This is to some extent, however, counterbalanced by the general average of barley land being of considerably inferior quality to that of wheat land, and after comparison of the safest authorities, an estimate of 16 maunds to the acre of irrigated land seems a fair one. The outturn of irrigated wheat-barley may be put at 15 maunds, and that of barley-gram at 14 maunds, since the ordinary return of both wheat and gram is lighter than that of barley.

For unirrigated land the following estimates have been framed:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division.	Benares Division.	Jhansi Division.	Kumaun Division.	Oudh.
Barley, ...	11	11	8	8	9	7	10	10
Barley-wheat, ...	10	10	7	7	8	6	9	9
Barley-gram, ...	9	9	6	7	8	7	8	8

Barley constitutes about $\frac{3}{5}$ths of the total produce when grown with either wheat or gram.

The weight of straw (*bhúsa*) may be taken as $1\frac{1}{2}$ times that of the grain.

Area.

The average area under barley in the 30 temporarily settled N.-W. Provinces Dis-

tricts is shown below by Divisions. The average has been calculated on the returns for 1879, 1880 and 1881 :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Barley.								
Irrigated, ...	1,09,319	33,515	1,06,444	98,417	3,76,638	3,174	2,863	7,30,370
Unirrigated, ...	1,75,418	2,52,850	74,178	88,767	2,02,087	482	3,502	7,97,284
Total, ...	2,84,737	2,86,365	1,80,622	1,87,184	5,78,725	3,656	6,365	15,27,654
Barley-Wheat.								
Irrigated, ...	60,962	27,120	83,146	32,045	1,93,887	19,160	1,106	4,17,426
Unirrigated, ...	1,29,836	2,43,766	72,694	46,841	1,05,290	3,671	3,369	6,05,467
Total, ...	1,90,798	2,70,886	1,55,840	78,886	2,99,177	22,831	4,475	10,22,893
Barley-Gram.								
Irrigated, ...	1,67,579	13,395	3,63,297	1,89,313	90,865	4,812	6	8,29,267
Unirrigated, ...	2,76,781	1,13,316	3,83,619	4,81,908	60,068	32,334	504	13,48,530
Total, ...	4,44,360	1,26,711	7,46,916	6,71,221	1,50,933	37,146	510	21,77,797
Grand Total, ...	9,19,895	6,83,962	10,83,378	9,37,291	10,28,835	63,633	11,350	47,28,344

No reliable data are available for determining the area under barley in Oudh and in the 5 permanently settled Districts of the N.-W. Provinces.

Explanation of Plate II.

1. Whole plant (reduced to ½ nat. size).
2 & 3. Plant in flower. } nat. size.
4. Ripe spike. }
5. Cluster of 3 spikelets. } enlarged.
6. A single spikelet. }
7 & 8. Back and front views of outer pale. } copied from Plate 293 Bentley and Trimen Med. Pl.
9 & 10. Back and front views of inner pale. }
11. A flower with the outer pale removed (enlarged).
12. Inner side of grain (nat. size).
13. Ditto (enlarged).
14. Back of grain. } enlarged.
15. Transverse section of ditto. }

HORDEUM VULGARE, LINN.

Drawn by K. Hormusji

Litho. T. C. Press, Roorkee.
Thos. D. Bona, Supdt.

AVENA SATIVA, *Linn.**

[*Vide* Plate III.]

ENGLISH, oats; VERNACULAR, jai.

Description.

An annual herbaceous grass belonging to the tribe *Aveneæ*, of the natural order *Gramineæ*. Stems 2-4 ft. high, erect, polished. Leaves few; sheaths long, smooth, striate, glaucous green; ligule prominent, broad, truncate; blade 5-6 in. long, linear lanceolate, tapering from the base, pale green. Spikelets few, laterally compressed, pendulous, arranged in large loose panicles, usually 2-3 flowered; florets widely open when in flower, one sessile, one stalked, and a third reduced to a slender stalked club-shaped rudiment; glumes 2, about equal, ¾-1 in. in length, rounded on the back, thin, membranous, veined, pale green, becoming white as the grain ripens; pales 2, shorter than the glumes, lower one faintly nerved, lanceolate, bifid, rounded on the back, smooth, afterwards hard and firm, pale green, awned; awn proceeding from the back of the pale and 1½ times as long, rough and twisted; upper pale rather shorter than the lower, thin, transparent, 2-toothed, margins inflexed. Within the pales are two small ciliate scales (lodicules). Stamens 3, exserted; anthers yellow. Styles 2, short feathery, white. Fruit (the grain) closely covered by, but not adherent to, the hard persistent pales, ½in. in length, narrowly oval-oblong, hairy, and with a deep furrow on the inside.

Distribution.

Oats have only recently found their way into the agriculture of these Provinces, through having been grown under English auspices round Cantonments and Stud depôts for the supply of horses. The only Divisions in which the cultivation of oats is reported to exceed 500 acres are Meerut and Rohilkhand, in the former of which it extends to 5,000, and in the latter to 3,000, acres. The extent of the cultivation in the Meerut Division is probably due to the influence of the Stud depôts at Saharanpur and Hapur (in the Meerut District), and it may be noted that the Meerut and Rohilkhand Divisions are the only localities in the Provinces where horse breeding is largely practised by natives.

Cultivation.

The cultivation of oats differs in no way from that of barley: they are, as a rule, grown on the better class soils near village sites, three fields in every five being irrigated in the Meerut Division, but only one field in every fifteen in Rohilkhand. With a copious supply of water it has been found that oats are an invaluable green fodder crop for the cold season, yielding as many as three cuttings, and then making sufficient growth to bear a thin crop of grain. A large area under oats is most successfully treated in this way each year at the Hissar Government Cattle Farm. When grown in this manner they class rather as a green fodder than as a grain crop.

Col. Parrot of the Saharanpur and Karnal Stud depôts reports that oats appear to exhaust soils very rapidly, and that even with manure and irrigation the outturn greatly decreases if they are grown continuously on the same land.

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* **References**:—Linn. Sp. Pl. Ed. I. p. 79; Bentley and Trimen Medicinal Plants, 292; Kunth Enum. Pl. i. 301; Steud. Syn. Gram. 230; DC. Geogr. Bot. 938.

Cost of cultivation.

The cost of cultivation per acre may be taken as the same as that of barley, and the outturn as 18 maunds on irrigated, and 10 maunds on unirrigated, land.

Area.

The area under oats as returned for the year 1880-81 in the 30 temporarily settled Districts of the Province is shown below by Divisions:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	3,278	217	81	252	7	...	...	3,835
Unirrigated, ...	2,379	3,058	295	181	33	...	...	5,946
Total, ...	5,657	3,275	376	433	40	...	...	9,781

Explanation of Plate III.

1. Entire plant (reduced to ½ nat. size).
2. Portion of stem with leaf. } nat. size.
3. Panicle in fruit. } nat. size.
4. Spikelet. } nat. size.
5. Ditto, ripe. } nat. size.
6. Flower and upper pale. } enlarged.
7. Lower pale. } enlarged.
8. Ovary with plumose styles and the ciliate lodicules. } enlarged.
9. Grain (nat. size).
10. Ditto, grooved side. } enlarged.
11. Ditto, back view. } enlarged.
12. Ditto, vertical section. } enlarged.
13. Ditto, lower portion (much enlarged).

AVENA SATIVA, LINN.

Drawn by H. Hermuaji

Litho. T. C. Press, Roorkee.
Thos. D. Bona, *Supdt.*

ORYZA SATIVA, *Linn.**

[*Vide* Plate IV.]

ENGLISH, **rice**; VERNACULAR, **dhán** (unhusked), **cháwal** (husked), **baranj**, (Persian).

Description.

Natural order *Gramineæ*, tribe *Oryzeæ*. Annual. Stems numerous, varying in height from 2-10 ft., lower portion floating or creeping, erect above, cylindrical, jointed, smooth, striate. Leaves with long close sheaths, the lower ones without blades; ligule prominent, often an inch in length, lanceolate, acute; blade linear, tapering, acute, 1-2 ft. long, and upwards of an inch in width, pale green, rough, edges serrulate and armed with minute forward prickles; midrib prominent. Panicles narrow, 8 in. to 1 ft. or more in length, at first erect, becoming more or less drooping as the grain ripens; rachis flexuose, angular, hispid, with tufts of soft hair at the base of the branches. Spikelets laxly disposed, stalked, 1-flowered, articulated with the swollen summit of the pedicel. Glumes small, the outer a little the longer, lanceolate acuminate, 1-nerved; pales 2, equal, longer than the glumes, boat-shaped, clothed with short bristly hairs especially at the upper part, coriaceous, persistent, pale green, becoming white, yellow, reddish-yellow or nearly black as the grain ripens; lower pale 3-nerved, blunt, acute or ending in a stiff smooth awn which often exceeds the spikelet. Lodicules 2, broad, fleshy, semi-transparent. Stamens 6, hypogynous; anthers linear, protruding from the pales when in flower. Ovary smooth, tapering; styles 2, about as long as the ovary; stigmas red, composed of rough spreading hairs. Fruit (the grain) enclosed in, but not adhering to, the persistent pales, oblong-ovoid, smooth, somewhat compressed.

Varieties.

The varieties which rice has developed are more numerous and more strongly marked than those of any other crop. In the District of Bareilly about 47 distinct varieties are enumerated, and it is probable that in the Provinces their number considerably exceeds 100. Their names, however, vary so greatly from District to District as to be of little or no assistance in identification, and hence no useful purpose would be served by giving a list of them here. Judged by their leading characteristics the varieties may be thrown into three classes—the *first*, including those with a tall habit of growth, with the ear protruded from the sheath, feathery and drooping, and with thin, usually yellow-husked grain; the *second*, including varieties with a shorter habit of growth and stouter stems, with the ear not so prominent and carried more erect than that of the preceding, and with thick yellow or red-husked grain; and the *third*, comprising the common varieties of paddy, with short, strong stems, ear partially enclosed in the sheath and grain-husk dark coloured or black.

The varieties of the first class are the most highly prized, the commonest being those known as *naha*, *bánsmatti*, *bánsphal* and *jhilma*. The *seondhi* and *sumhára* are the principal varieties of the second class, while *sathi* (so called from its growth covering 60 days) is far the most important of those included in the third class, and, if its area be alone regarded, the most important of all the varieties. *Munji* is a term of varying meaning, denoting in some places (*e.g.*, Muzaffarnagar) high class rice, and in others

* **References**:—Linn. Sp. Pl. Ed. I. 333; Roxb. Fl. Ind. II. 200; Bentley and Trimen Med. Pl. 291; Powell Punj. Prod. 231; Drury Useful Pl. of Ind. 321.

being merely a general term for rice sown broad-cast and not transplanted. This leads to another and much simpler method of classification, in which the varieties may be grouped according to the method of their cultivation, as (1) those transplanted from seed-beds, and (2) those sown broad-cast. As a general rule the finer varieties, falling under the first two classes above named, are raised in seed-beds and planted out, while the coarser kinds are sown in the field broad-cast. It may be mentioned that a kind of rice (*Hygrorhiza aristata, Nees*) is commonly found growing wild round the edges of lakes and marshes, being known as *passari, passai* or *phasahi*, and a sub-variety as *tinni* (Partabgarh). The grain is eaten by the poorer classes, being often collected by sweeping the plant heads with a basket.

Distribution.

The total area under rice in the whole of the N.-W. Provinces and Oudh amounts to some 49 lakhs of acres, only 27 lakhs of which are in the 30 temporarily settled N.-W. Provinces Districts, being 11 per cent. on their total cropped area, and 21 per cent. on the area under kharif crops. Its cultivation is perhaps more markedly localized than that of any crop except cotton and sugar, and it varies between $\frac{6}{11}$ of the kharif crop area in Gorakhpur to only $\frac{1}{33\frac{1}{100}}$ in Muttra. The percentage of the rice area to the total cropped area in the 30 temporarily settled Districts of the N.-W. Provinces is shown by Divisions below:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Gorakhpur and Basti Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Percentage of rice area to total cropped area, ...	4·1	14·6	1·9	6·3	31·4	1·3	49·1

The cultivation reaches its maximum in the belt of Districts underlying the Himalayas, and increases very largely as we go eastwards. This merely of course illustrates the fact that a plentiful supply of water is the first requisite for rice growing.

Seasons.

There is greater latitude in the period for sowing and harvesting rice than in the case of any other crop, it being sown in all months from January to July, and harvested in all months from May to November. The rice, however, which is sown before the commencement of the monsoon rains bears but a very small proportion to the total, and the seasons in which the greater portion is grown are June to August for broad-casted, and June to November for transplanted, rice. Taking first of all broad-casted rice, by far the greater portion is sown on the break of the monsoon, and is ready for cutting in from 2 to $2\frac{1}{2}$ months, *i.e.*, in *bhádon* (August) or *kuár* (September), and hence it is often known as *bhadoi* or *kuári*. The rapidity of its growth is signified in the name of one of the commonest varieties, which is called *sathi*, or 60-day, rice. But a certain amount of broad-casted rice is sown two months before the monsoon rains can be expected, and in this case there are two methods of cultivation. Either the rice germination is promoted and its growth stimulated by frequent and copious irrigation until the rains break, or taking advantage of a fall of rain in April and May, the ground is ploughed up and sown, but the seed is allowed to lie unirrigated, and the young plants should not come

up before the advent of the rains induces germination. The method is a very risky one, since, if the seedlings come up before the rains commence, they are speedily dried up and the crop ruined. The principal object in early sowing is to be able to harvest early, and get the rice crop off the ground in time to be followed by one in the rabi, and by having the seed in the ground by the time the rains commence, the first fall is utilized in bringing up the young plants instead of in merely preparing the ground for ploughing.

Nearly the whole of the transplanted (or *jarhan*) rice is sown in seed-beds at the beginning of the rains, planted out after a fortnight or three weeks, and cut in *aghan* or November, whence it is also called *aghani*. A very small proportion, however, called *boron*, *jethi*, or hot weather rice, is sown in January, planted out in February, and cut in May. This is only practised in slimy soil, along the edges of tanks or beds of rivers, which are planted with rice as the water becomes shallow from evaporation. Great labour of an especially disagreeable kind is required, and this method of cultivation is therefore chiefly confined to the fisher and boatmen castes. The area under *boron* rice in 1880-81 in the 30 temporarily settled Districts of the N.-W. Provinces was only returned as a little over 5,000 acres.

No particular rotation is followed; in damp localities it often alternates with sugar-cane, and in the western Districts of the Provinces with gram, barley or peas. But it is commonly grown year after year in the same land and, moreover, when broad-casted and cut early, is generally followed by a crop in the succeeding rabi, and the land is thus drained by two crops within the year.

Mixtures.

Rice is almost always sown alone, the peculiar conditions of its cultivation not suiting any other crop. Occasionally the greater millet (juár) is sown mixed with it, but more as an insurance against an over-light rainfall than in the hope of gathering a double crop.

Soils and manure.

The suitable soil is stiff clay which commonly forms the bed of the drainage depressions and basins, in which rice cultivation most frequently occurs. Rice can even be grown on *usar* or saline clay, provided that an ample supply of water be given, and evaporation from the soil be checked by never allowing the surface to become dry. Manure appears to be very little used for broad-casted rice. The nurseries in which transplanted rice is raised are generally heavily manured, but the application of manure to the fields in which the seedlings are transplanted is only reported from the Districts of the Benares Division in the Gogra-Ganges Doáb, where cattle are said to be herded on rice fields, and earth impregnated with saltpetre is occasionally used as a top dressing.

Tillage.

A great portion of the rice land in the Sub-Himalayan Districts is prepared by being dug over by the mattock during the cold and hot weather months, when the soil has been softened by a fall of rain. Labour is cheap in these Districts, and practice has produced dexterity, and in consequence an acre can be dug in this manner to a depth of six inches for about Rs. 2-8, while at the contract rates allowed in Doáb Districts it would cost at least Rs. 8 or Rs. 10. For land not dug in this way, the number of ploughings varies according as the crop is to be sown broad-cast or planted out, being two or three in the first case, and from four to six in the second. The soil is pulverized and weeds collected by a rough harrow made by fixing a row of pegs in the ordinary log clod crusher. If the land lie at all saline the harrow is not used, since by rendering the

earth more compact it is said to facilitate evaporation, which brings of course the salt to the surface.

Sowing. For sowing, the soil must be thoroughly moist, but may be a miry slush, on the surface of which the seed is scattered and harrowed in. If the rice is sown broad-cast 40 seers to the acre are held sufficient. If seedlings are to be raised in a nursery much thicker sowing is followed. It is a common practice, especially when the weather at sowing time is very wet, to give an artificial stimulus to germination by soaking the seed in water for a night, and then leaving it for a couple of days covered with damp grass. If the crop is to be transplanted, the nursery should be about $\frac{1}{15}$th the size of the field. The seedlings are taken up when about a foot high, and planted out in regular lines at distances of six inches, from two to six seedlings being planted together.

Irrigation. For rice which is grown in the hot weather months, frequent and copious irrigation is absolutely necessary, whether the District be moist or dry. Rice sown at the commencement of the rains and cut in August or September under ordinary circumstances needs no watering, but the transplanted varieties, which are not ready for harvesting till November, need two or three waterings after the rains have ceased. Of the total area under rice in the 30 temporarily settled N.-W. Provinces Districts, only 15 per cent. is returned as irrigated, and this may be presumed as the proportion which transplanted bears to broad-casted rice.

The rain water is carefully economized by surrounding the field with a bank which prevents any great loss of water by surface drainage. Irrigation, if required at all, is required in such quantity that wells are almost, if not quite, useless for the purpose, and the crop can only afford the less costly water which can be derived from tanks, rivers, or canals. The effect of the Ganges Canal on rice cultivation is seen very clearly in the Muzaffarnagar District, where transplanted and irrigated rice, which was formerly almost unknown, now occupies 50 per cent. of the total rice area.

Weeding. At least one weeding is, as a rule, given to broad-casted rice. Planted rice is reported in Cawnpore to be more frequently weeded than broad-casted, but in Allahabad it requires no weeding at all. The explanation of the discrepancy is to be looked for in the previous preparation of the field; if the weeds were thoroughly eradicated then, subsequent weedings might be rendered unnecessary.

Harvesting. The crop is cut with sickles in exactly the same manner as wheat or barley. The most common method of threshing is by beating out the grain with sticks, but it appears that in some localities the grain is trodden out by cattle, the ears having been previously separated from the straw, which is too succulent to break up into chaff as is the case with wheat or barley. The straw called (*pial*) is used for cattle fodder when all else fails, but is very innutritious, and possibly this may be the reason why the agricultural cattle of rice Districts are the worst in the Provinces. The grain after being threshed out does not lose its husk, and in this condition is known as *dhán*. The husk is separated by pounding the grain either with a wooden pestle (*mansari*) in a mortar (*okhali*), or in the lever mill known as the *dhekoli*. The husking is sometimes facilitated by soaking the grain in warm water and allowing it to dry. Of course so rude a process destroys some portion of the produce, and of the 60 to 70 lbs. of cleaned rice which can

be obtained from 100 lbs. of *dhán*, from 10 to 15 per cent. will be broken and crushed and of little value.

Diseases and injuries.

Rice has most to fear from the green fly called *ganduki* or *tanki*, and since the attacks of these insects do not commence until towards the end of August, it is the finer varieties which suffer most. Strong and healthy plants suffer much less than backward ones, and this furnishes another reason in favour of sowing being as early as possible.

Cost.

The following is the cost of growing an acre of broad-cast and transplanted rice:—

Broad-cast.	Rs.	A.	P.	*Transplanted.*	Rs.	A.	P.
Ploughing (twice), ...	1	8	0	Ploughing (four times), ...	3	0	0
Harrowing (twice), ...	0	4	0	Harrowing (twice), ...	0	4	0
Seed (40 seers), ...	1	8	0	Seed (25 seers), ...	0	15	0
Sowing, ...	0	4	0	Sowing, ...	0	1	0
Weeding (twice), ...	3	0	0	Manure (for seed-bed), ...	0	8	0
Reaping, ...	1	8	0	Transplanting, ...	4	0	0
Threshing (at $\frac{1}{12}$th produce), ...	1	8	0	Weeding (twice), ...	3	0	0
Cleaning, ...	0	6	0	Watering (three times canal flush),	7	0	0
				Reaping, ...	1	8	0
				Threshing, ...	2	0	0
				Cleaning, ...	0	6	0
Total, ...	9	14	0	Total, ...	22	10	0
Rent, ...	4	0	0	Rent, ...	6	0	0
Grand Total, ...	13	14	0	Grand Total, ...	28	10	0

This is exclusive of husking, which costs about 6 annas per maund of husked rice. A woman can husk 15 seers of *dhán* in a day, the usual rate of payment being 2 annas for 5 seers, about $\frac{2}{3}$rds of which will be cleaned rice.

Outturn.

The discrepancies between available authorities as regards the average outturn of a rice field are greater than usual, and can only be explained on the hypothesis that in some cases the figures relate to broad-casted, and in others to transplanted, rice. The most elaborate estimate is that framed by Mr. Moens for the Bareilly District, which puts the outturn at 1,218 lbs. (or 14·8 maunds) per acre, although here also it is not specified how far this estimate is dependent on the rice being transplanted or not.

In the Districts of the Meerut, Rohilkhand and Benares Divisions and in north Oudh, broad-casted and unirrigated rice may be assumed to yield an average produce of 12 maunds per acre, while in the drier Districts towards the centre and south of the Provinces, 10 maunds is the highest average which can be safely taken.

The outturn of transplanted and irrigated rice may be estimated at 16 maunds per acre, the produce being superior to that of broad-casted rice in quality as well as quantity, commanding at least 50 per cent. higher prices in the market.

These outturns are of *unhusked* rice, and must be reduced by at least 25 per cent. to arrive at the weight of *husked* grain. The weight of straw is from $\frac{1}{3}$ to $\frac{1}{2}$ as much again as that of the grain.

The average area under irrigated and unirrigated rice in the 30 temporarily settled N.-W. Provinces Districts is shown below by Divisions, having been calculated from the returns of the last three years:—

Rice.	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	86,449	29,132	17,731	78,084	2,18,748	2,248	34,676	4,67,068
Unirrigated, ...	1,20,255	6,30,173	65,674	1,98,472	11,59,045	15,056	54,752	22,43,427
Total, ...	2,06,704	6,59,305	83,405	2,76,556	13,77,793	17,304	89,428	27,10,495

Adding to this 22,00,000 acres on account of Oudh and the permanently settled N.-W. Provinces Districts, the total area under rice is brought up to some 49 lakhs of acres.

Trade. The traffic by rail in rice during the last three years is summarized below :—

	1878-79.	1879-80.	1880-81.
Gross import.	maunds.	maunds.	maunds.
From Bengal, ...	2,74,829	43,012	10,34,366
„ other places, ...	17,506	13,430	20,873
Total, ...	2,92,335	56,442	10,55,239
Gross export.			
To Punjab, ...	2,20,683	7,79,207	5,45,208
„ Rajputana, ...	73,692	3,27,144	2,54,816
„ Other places, ...	72,437	1,66,539	39,687
Total, ...	3,66,812	12,72,890	8,39,706
Net { Import, ...	...	...	2,15,533
Net { Export, ...	74,477	12,16,448	...

ORYZA SATIVA, L.

Drawn by H. Hormusji.

Litho T. C Press, Roorkee.
Thos D. Bona, *Supdt.*

ZEA MAYS, *Linn.**

[*Vide* Plate V.]

ENGLISH, **maize**; VERNACULAR, **maka, makai, junri** or **bara juár** (in the eastern Districts, where millet is called **chota juár**).

Description.

Natural order *Gramineæ*, tribe *Maydeæ*. A tall annual grass. Stems 4-10 ft. high, smooth, striate, solid, the central portion soft and spongy. Leaves numerous, close together; sheaths large and full, somewhat compressed, auricled at the base, upper part hairy; ligule short, truncate, torn; blade of leaf 1-1½ ft. long, linear lanceolate, acute, smooth; midrib prominent below; margins wavy, ciliate. Flowers unisexual; spikelets monœcious, 2-flowered; male spikelets many, arranged in pairs on the spike-like branches of a large terminal drooping panicle; glumes 2, about equal, tinged with purple; pales 2, nearly equal, falling short of the glumes, lower 3-nerved, upper 2-nerved and with inflexed margins; lodicules fleshy, truncate; stamens 3, protruded; female spikelets nearly sessile, closely arranged in pairs on a thick spongy axis, forming a compact cylindrical spike surrounded at the base by broad imbricated bracts, upper flower of spikelet barren; glumes 2, broad, thick and fleshy at the base, the lower emarginate, ciliate, the upper truncate; pales 2, lower broad and blunt, the upper much longer, closely adhering to the ovary; lodicules none; ovary sessile, ovoid, styles very long, filiform, drooping. Fruit (the grain) roundish or reniform, compressed, smooth, shining, yellow white red or spotted.

Varieties.

Maize is undoubtedly an introduction from America, and its cultivation is of recent date compared with that of the other cereal crops. Possibly for this reason it does not appear to have developed any well marked varieties except perhaps in the eastern Districts, where its cultivation is attended by more care than it generally receives. So far as the colour of the grain is concerned there are endless varieties, and the cobs may be of any tint from a dark purplish red, through yellow and orange, to a pure white. But the most important variety is that grown in Jaunpur and Azamgarh, in which the cobs are of double the usual length, and the plants of taller growth than the ordinary. The grain of this variety is, however, nearly a month longer in maturing.

Distribution.

The total area under maize in the 30 temporarily settled N.-W. Provinces Districts may be put at 7 lakhs of acres, or 3 per cent. on the total cropped area. Its cultivation is spread over the whole area of the Provinces with the exception of Bundelkhand, in which it is hardly known. It reaches its maximum in Gorakhpur and Basti. There are, however, considerable differences between the area under maize in closely adjacent Districts, which can only be explained on the supposition that its cultivation has hardly yet lost novelty and is still on the increase. Thus in Cawnpore the area under maize in 1880 is returned as 28,233 acres, while in Fatehpur it is only 187 acres.

Seasons.

Maize is a kharif crop and ranks next after broad-casted rice in the rapidity with which it comes to maturity. It is sown, as a rule, when the rains break, but in localities

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* **References**:—Linn. Sp. Pl. Ed. I. 971; Roxb. Fl. Ind. III. 568; DC. Geogr. Bot. ii. 942; Bonafous Hist. Mais. tt. 1—12; Bentley and Trimen Med. Pl. 296; Powell Punj. Prod. 230.

where the green cobs are likely to command a sale as vegetables, sowing often takes place in May, after the ground has been irrigated, since in this case it is of great importance to be early in the market. In the beginning of July a single cob will fetch a pice, while at the end of August a maund of them can be purchased for eight annas. If sown when the rains commence, the ordinary small cobbed varieties are ready for cutting at the end of August, and leave therefore ample time for preparation of the ground for a rabi crop. Hence maize is almost invariably followed by either wheat or barley, and very nearly the whole of the area under maize may be presumed to bear two crops in the year.

Mixtures. As a rule it is grown alone since few other crops would keep pace with it in maturing; occasionally cucumbers are grown between the lines. It is not uncommon too to mix a certain proportion of the lesser millets (*kakuni* and *mandwa*) and a little pulse (*urd*), since these require but little more time to ripen and secure some measure of return in the not uncommon case of the maize completely failing.

Soils and manuring. The land selected is almost invariably that lying immediately under the village site, and fertilized as much by the daily visits of the villagers as by the direct application of manure. From two to four tons of cattle dung and ashes are commonly applied, but this is less to stimulate the maize than the rabi crop which is to follow it. It is reported that in the Bareilly District the use of manure depends on whether the rent is levied in cash or as a fixed proportion of the produce. In the former case the maize is well manured, and is followed by a valuable crop, such as wheat or barley, while in the latter case no manure is used, and the succeeding crop is one of the coarser spring pulses. It would be difficult, however, to decide whether the levy of the rent in kind is the cause or effect of the inferior cultivation.

Tillage and sowing. The ground is ploughed from three to six times, and the clods are broken by the log clod crusher being drawn over the field. The seed is sown by being either scattered broad-cast and ploughed in, dropped into the furrow behind the plough,—every other furrow being left blank,—or (rarely) dibbled in by hand. As a rule about 6 seers of seed are used to an acre.

Irrigation. Maize requires a constant but moderate supply of moisture, and suffers very greatly from any lengthened break in the rains. Accordingly in 1881, a year in which the rainfall was abnormally light, $\frac{8}{9}$ths of the total area is returned as irrigated, and in ordinary years the irrigated area amounts to $\frac{1}{3}$rd of the total, although the crop only occupies the ground for $2\frac{1}{2}$ months in the height of the rainy season. Maize, which is sown before the commencement of the rains in order to secure an early market, requires of course constant watering, but this constitutes a small proportion of the total crop, and adds but little to the area under irrigation. In ordinary years one, or at the most two, waterings are sufficient to carry the crop over the break in the rains which usually occurs during a fortnight in August.

Weeding. The crop is always weeded, generally twice, and the earth is carefully banked up round the roots, so that each plant appears to be standing on a little mound of its own. This forms one of the most expensive items in the cultivation.

Harvesting. If the cobs are to be sold as vegetables they are pulled while green, and the stalks in this case are of some use as cattle fodder. Otherwise the crop is not harvested until

the leafy envelopes surrounding the cobs are dry and shrivelled, when the stalks are so hard and desiccated as to be almost useless for any purpose but thatching. The cobs may be either pulled by themselves and the stalks left standing in the field until there is leisure to cut them, or the stalk may be cut with the cobs on them, and heaped in shocks to dry before threshing. If the grain is to be separated from the cob before it is perfectly dry, the task is a slow and troublesome one, it being necessary to deal with each cob separately, forcing the grain from it by the fingers or the point of a trowel. When the cobs are perfectly dry threshing can be easily and speedily performed by beating a heap of them with a rough flail or stick, or treading the grain out by cattle. The weight of grain varies from one-half to two-thirds of that of the cob. If the outturn of grain does not promise well, the stalks are sometimes cut while green and given to cattle, since the maize stalk when young and succulent contains a very large amount of saccharine matter and is a valuable fodder.

Diseases and injuries.

The maize is singularly free from disease of any kind, and the only insect from which it suffers is a small caterpillar called *salai*, which burrows in the stalk and leaf sheaths. It is on the other hand more liable than any other crop to the depredations of parrots, squirrels, jackals and porcupines, as well as human thieves, and unless carefully watched by night and day, the crop has small chance of reaching the threshing floor. A tall platform is erected in the centre of the field, from which the cultivator or one of his family are but seldom absent for at least a fortnight before harvest time. Occasionally a mound of earth at one corner of the field affords the necessary vantage ground. Armed with a sling or catapult, and maintaining a constant series of shouts and cries, the watcher wages unceasing war during the day with hordes of parrots and squirrels which come crowding from the neighbouring groves, and during the night with jackals, porcupines and wild swine. Often during the night time he descends from his platform, and joining a cultivator from a neighbouring field, gives and obtains assistance in patrolling the crops. It goes hardly then with any thief caught pilfering. The ringing and not unmusical cries of the watchers in early September mornings are always pleasantly associated with the return of the cold weather.

The damage which maize sustains from flooding has been already noticed, and for this reason it is generally grown on the uplands out of reach of any but abnormal floods.

Cost of cultivation.

The cost of cultivation of unirrigated maize is estimated below:—

	Rs.	A.	P.
Ploughing (four times),	3	0	0
Clod crushing,	0	4	0
Sowing,	0	14	0
Seed (6 seers),	0	3	0
Weeding (twice),	3	0	0
Watching (proportional share),	0	12	0
Cutting, (on an outturn of 16 maunds),	1	0	0
Threshing and cleaning, (on an outturn of 16 maunds),	1	4	0
Manure (half value of three tons),	1	8	0
Total,	11	13	0
Rent (one-third of total rent for the year),	2	8	0
Grand Total,	14	5	0

Average outturn.

The general average outturn for the Provinces may be taken as 10 maunds for unirrigated, and 14 maunds for irrigated, maize. The Settlement officers of Bijnor and Aligarh arrived at averages of $7\frac{1}{2}$ and $10\frac{1}{2}$ maunds respectively, while the careful experiments of Mr. Moens in Bareilly, give $15\frac{1}{2}$ maunds for manured land, 12 maunds for unmanured land, and $12\frac{1}{2}$ maunds as the general average for the District. In both Etawah and Cawnpore the average outturn is returned as 12 maunds.

Area.

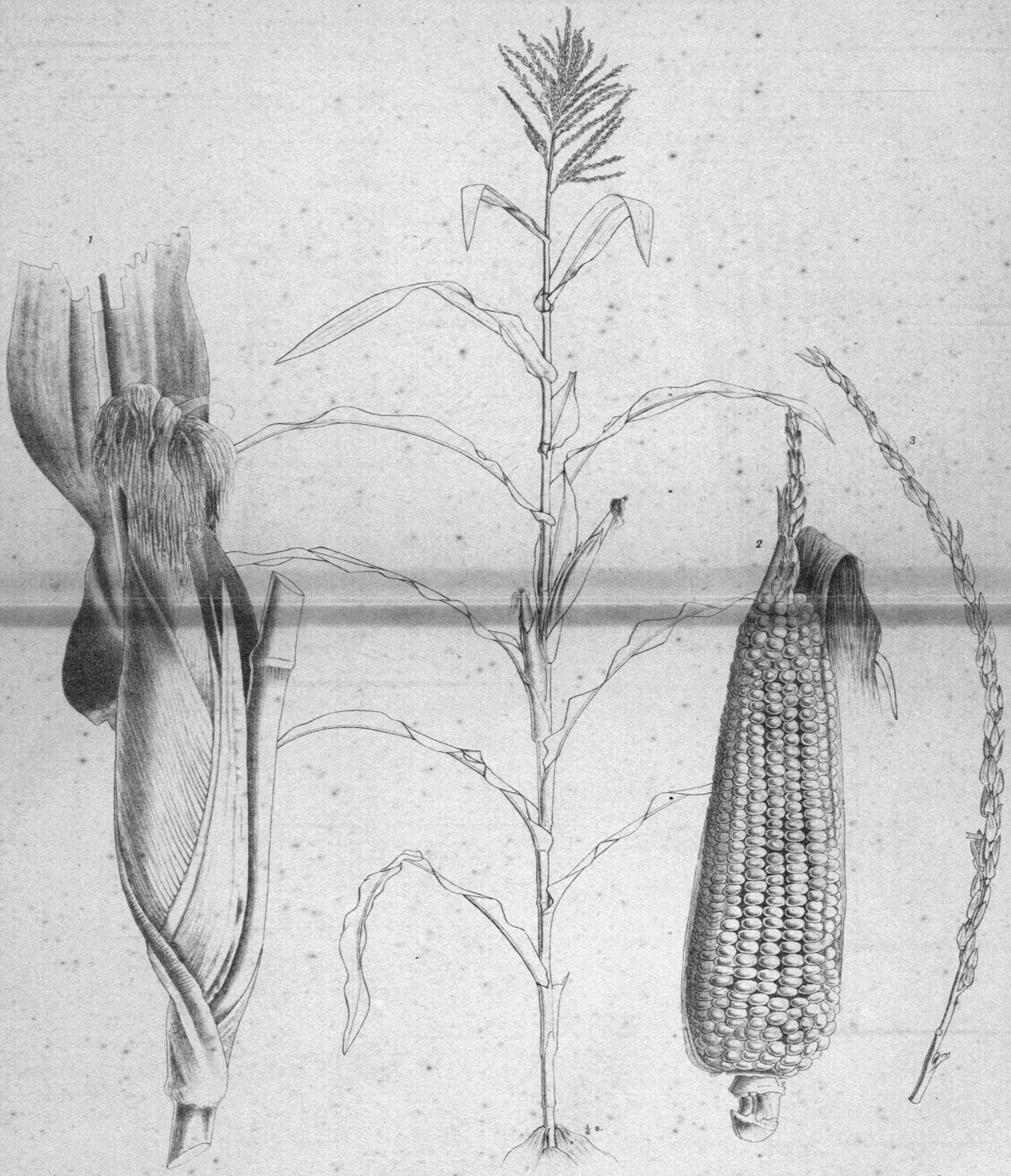
The area under maize during the last three years in the 30 temporarily settled N.-W. Provinces Districts is shown below by Divisions:—

Maize.	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	1,45,176	8,142	49,273	7,774	17,784	29	1,003	2,29,181
Unirrigated, ...	1,66,450	85,704	78,914	23,298	1,18,350	8,307	8,744	4,89,767
Total, ...	3,11,626	93,846	1,28,187	31,072	1,36,134	8,336	9,747	7,18,948

No statistics are available of the area under maize in Oudh and the 5 permanently settled N.-W. Provinces Districts.

Explanation of Plate V.

1. Entire plant (reduced to $\frac{1}{4}$ nat. size).
2. Single branch of male inflorescence (nat. size).
3. Spike of female flowers enclosed in the spathe-like bracts. } nat. size.
4. Ripe cob. }



Drawn by H. Hormusjt

ZEA MAYS, L.

Litho. T. C. Press, Roorkee.
Thos. D Bona, Supdt.

SORGHUM VULGARE, *Pers.**

[*Vide* Plate VI.]

ENGLISH, **great millet**; VERNACULAR, **juár, junri** (N.-W. Provinces Districts west of Allahabad), **choti juár** or **junri** (Districts of Oudh and the Benares Division, where maize is called *bari junri*), also called **bajra jhupanwa** (in the Azamgarh District, where the bulrush millet (*Penicillaria spicata*) is known as *bájra tangunanwa*). The **cholum** of the Madras Presidency.

Description. A tall handsome grass belonging to the tribe *Andropogoneæ*, of the natural order *Gramineæ*. Stems erect, variable as to height, thick and succulent, often tinged with red or yellowish blotches. Leaves broad, narrowing gradually to their tips, smooth except at the junction with the sheath; midrib prominent beneath channelled above; sheaths very long. Flowers in dense ovate panicles, heads nodding before ripening. Spicules in pairs, 1-flowered, one sessile and hermaphrodite, the other stalked and bearing only stamens. Glumes about equal, hard and firm, especially those of the fertile flowers, lower 3-fid; pales 2, somewhat transparent, lower one rather larger, concave, acute, upper bifid, awned; awn jointed. Stamens 3. Styles 2. Grains about ⅛ in., smooth, white or red.

Varieties. There are numerous varieties of juár as might be expected from the large extent to which it is cultivated. They may be primarily grouped according as the seed is white or red, the former class being the most esteemed from the superiority of its stalks as cattle fodder, as well as from the better quality of its grain. Three well marked varieties are (1), the double seeded, which has two grains within a single husk; (2), the dwarf, grown in the Allahabad District, in which the stalks do not grow to a greater height than 3 or 4 feet instead of 7 or 8; and (3), the variety, known as *cháhcha* in the Cawnpore District, in which the grain is completely covered by the husk, and which is said to suffer less from the depredations of birds than the ordinary kinds.

The dry stalks and leaves of juár chopped into small pieces form the ordinary cattle fodder of the country for some months in the year, being known by the name of *karbi*. Occasionally juár is grown solely for cattle fodder and not for its grain at all, in which case the stalks are cut while green before the seed has had time to mature. It is almost the only green fodder crop grown as such in the Provinces, and hence when grown for this purpose has no more distinctive name than *chari*, which simply means fodder. Chari cultivation is, however, almost entirely restricted to the Districts of the Meerut Division, where the cattle are mostly purchased from the outside, and are of a far better quality than those in other parts of the Provinces. Its value as a green fodder may be inferred from the following analysis, made by Professor Voelcker, in which its nutritive qualities are compared with those of turnips:—

	Chari.	Turnips.
Water, ...	85·17	90·43
Flesh forming matters, ...	2·55	1·04
Fatty and heat producing matters, ...	11·14	7·89
Inorganic matters, ...	1·14	·64
	100·00	100·00

* **Synonyms**:—*Andropogon Sorghum*, Roxb. Fl. Ind. i. 269. *Holcus Sorghum*, Linn.

Distribution.

The area under juár is larger than that under any other kharif crop with the exception of rice, and amounts to nearly 36,98,000 acres, 31½ lakhs acres of which are in the 30 temporarily settled N.-W. Provinces Districts, forming 13 per cent. of their total cropped area, and 25 per cent. of the area under kharif crops.

It is, however, almost entirely confined to the Districts of Rohilkhand, the Doáb and Bundelkhand, and comparatively rare in the east of Oudh and in the Districts of the Benares Division, where its place is taken by rice. This is shown by the subjoined figures:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Gorakhpur and Basti Districts only.	Jhansi Division.	Tarai District.
Percentage of area under juár-arhar *and* chari *in the 30 temporarily settled N.-W. Provinces Districts.*							
To total kharif cropped area,...	29·24	10·73	37·95	40·67	0·52	42·27	1·50
To total cropped area, ...	14·26	5·65	20·74	22·14	0·25	23·85	1·01

Seasons.

Juár is a kharif crop, being sown at the commencement of the rains and cut during November. When grown for fodder and irrigation is available, it is often sown in the hot weather, before the commencement of the rains, that it may be got off the ground as soon as possible, since it is generally followed by a crop in the succeeding rabi; this rarely if ever happens with juár when grown for its grain. No particular rotation appears to be followed, but it frequently alternates with rice on clay or loamy soils not subject to flooding.

Mixtures.

It is comparatively rarely sown alone, being, as a rule, mixed with several other crops, of which *arhar* (*Cajanus indicus*) is the chief. The oilseed called *til* or *gingelly* (*Sessamum indicum*) and the low growing pulses *múng*, *urd* or *másh* (*Phaseolus mungo* and *radiatus*) and *lobia* or *rawás* (*Vigna catiang*) form an undergrowth in most juár fields, yielding but a small return if the juár prospers and overshadows them, but occasionally forming the principal part of the crop if the juár suffers from failure of rain, which it feels more keenly than its deeper rooted associates.

Soils and manuring.

Loamy or clayey soils are preferred, where possible, and perhaps the best crops of juár in the Provinces are borne by the heavy black soil of Bundelkhand. So far indeed as soil is concerned juár in the kharif answers to wheat in the rabi, the place of barley and its mixtures being taken by the bulrush millet (*bajra—Penicillaria spicata*). Manure is but rarely given, unless the crop be grown for fodder, when it is generally succeeded by a rabi crop, and the land requires therefore artificial stimulation.

Tillage.

The number of ploughings varies from one to four; land which has borne a crop in the preceding rabi not being held to require so much tillage as land which has lain fallow since the end of the kharif preceding (Bareilly). Clods are usually broken before sowing by the use of the log clod crusher.

Sowing.

The first sowings of the kharif are those of cotton, and as soon as these are finished juár is commenced with. The seed is sown broad-cast and ploughed in, being used at the rate of 3 to 6 seers per acre if for a grain crop, and 12 seers per acre if for fodder, when thickness is the chief thing looked to. The seed of the minor crops (*arhar*, *múng*, &c., known collectively as *utara*) is mixed with the juár seed and scattered with it; *lobia* alone being sown by hand in lines across the field (Cawnpore). In some parts of the Provinces the finest heads are picked out at each harvest and set aside for sowing in the succeeding year (Cawnpore).

Irrigation.

Irrigation is very seldom used, unless the crop has been sown before the commencement of the rains, or the season is peculiarly unpropitious. The crop is generally weeded at least once, sometimes by hand, but often by merely driving a plough in lines through the field when the plants are about a foot high, so as to open out the soil round the plant roots which has a very beneficial effect.

Harvesting.

The *til* and the pulses (with the exception of *arhar*) are first of all gathered and carried to the threshing floor; the juár is harvested a fortnight later, generally by cutting off the heads (called (*bhuttas*) with the sickle, leaving the stalks standing in the field till the cultivator has leisure to cut and stack them. The grain is trodden out by cattle and winnowed in the usual way. As an illustration of the superstitious observances which attend almost every agricultural process, and which are especially prominent at sowing and harvest time, the following description of juár threshing is taken from Mr. Wright's Memo. on the Agriculture of the Cawnpore District. "The juár "was heaped by the cultivator in the shape of the figure 8, one end towards the Ganges, "and a sickle and a branch of *madár** in honour of Shaikh Madár (a local saint) stuck "up in it. All round the heap a line of cow-dung was traced, and the smoke of a sacri- "ficial fire made to blow upon the heap to keep off evil spirits (*jins*). A double handful "of grain was given in honour of Shaikh Madár, one to the village minstrel (*bhát*), one "to the Brahmin, one to the family priest (*parohit*), and half a seer each to the village "carpenter, blacksmith, barber and water-carrier."

Diseases and injuries.

The most peculiar of the diseases to which juár is liable is that which makes the young stalks poisonous to cattle if eaten by them when semi-parched from want of rain. Of the fact there can be no doubt; in the scarcity of 1877 large numbers of cattle were known to perish from this cause, their bodies becoming inflated after a meal of the young juár plants, and death ensuing shortly afterwards, apparently in severe pain. A good explanation is not, however, forthcoming. The opinion universally accepted by natives is that young juár when suffering from deficiency of rain becomes infested with an insect called *bhaunri*, to which its poisonous effect on cattle is due. Immediately rain falls the insect is said to perish, and unless the ears have appeared before the rain failed, the crop often recovers itself and yields a good outturn of grain. Juár is peculiarly liable to a species of bunt (*Tilletia*), a parasitic fungus well known in English corn-fields, which converts the whole contents of grains, externally apparently perfectly healthy, into a foul greasy dark coloured powder. But birds and squirrels are probably the worst enemies the cultivator has to contend with, and their depredations necessitate the crops being watched for at least 25 days before it is cut, which adds of course to the cost of cultivation.

* A common weed—*Calatropis gigantea.*

Cost of cultivation.

The cost of cultivation per acre is as below :—

	Rs.	A.	P.
Ploughing (twice), ...	1	8	0
Clod crushing (twice), ...	0	4	0
Seed (6 seers), ...	0	3	0
Sowing, ...	0	13	0
Weeding (once), ...	2	0	0
Watching, ...	0	12	0
Cutting, ...	0	10	0
Threshing, ...	1	8	0
Cleaning, ...	0	3	0
Total, ...	7	13	0
Rent, ...	6	0	0
Grand Total, ...	13	13	0

Average outturn.

The average outturn of juár on irrigated land is about 10 maunds grain and 60 maunds dry fodder, and of *chari* about 300 maunds green fodder, equal to 100 maunds dry fodder. For irrigated land the general average is 8 maunds grain and 45 maunds dry fodder, *chari* yielding 280 maunds green fodder, equal to about 90 maunds when dry. These are the averages for *juár* sown alone or with only the smaller pulses. When *arhar* is associated with it the outturn is decreased by about 25 per cent. The outturn of the subordinate crops may be put at—*arhar* 5 maunds, other pulses 2 maunds, *til* ½ maund.

Area.

The area under *juár*, *juár-arhar* and *chari* in the 30 temporarily settled N.-W. Provinces Districts, being the average for the three years 1878, 1879 and 1880, is shown by Divisions below :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Juár.								
Irrigated, ...	16,856	887	13,111	1,412	456	210	164	33,096
Unirrigated, ...	3,13,746	1,45,398	2,88,736	3,52,292	2,658	2,19,552	1,483	13,23,865
Total, ...	3,30,602	1,46,285	3,01,847	3,53,704	3,114	2,19,762	1,647	13,56,961
Juár-arhar.								
Irrigated, ...	7,890	236	24,139	10,590	886	153	...	43,894
Unirrigated, ...	1,84,322	88,241	5,36,735	6,01,435	4,408	84,449	2	14,99,592
Total, ...	1,92,212	88,477	5,60,874	6,12,025	5,294	84,602	2	15,43,486
Chari.								
Irrigated, ...	12,147	100	989	193	1,984	1	80	15,444
Unirrigated, ...	1,89,091	20,435	11,231	8,334	2,052	321	168	2,31,632
Total, ...	2,01,238	20,535	12,220	8,527	4,036	322	198	2,47,076
Grand Total, ...	7,24,052	2,55,297	8,74,941	9,74,256	12,444	3,04,686	1,847	31,47,523

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SORGHUM VULGARE, PERS.

Drawn by H. Hormusji.

Litho T. C. Press, Roorkee
Thos D. Bonn, *Supdt.*

Making a rough estimate of 5,50,000 acres for Oudh and the permanently settled Districts of the N.-W. Provinces, the total area under this crop in the N.-W. Provinces and Oudh is brought up to nearly 36,98,000 acres.

Explanation of Plate VI.

1. Upper part of plant showing one spike in flower, and another in fruit (nat. size).
2. Leaf (nat. size).
3 & 4. Clusters of spikelets (slightly enlarged).

PENICILLARIA SPICATA, *Willd.**

[*Vide* Plate VII.]

ENGLISH, **bulrush millet**; VERNACULAR, **bájra, bájri, lahra, bájra tangunanwa** (in Azamgarh where the great millet is called *bájra jhupanwa*). The **chambu** of the Madras Presidency.

Description. Natural order *Gramineæ*, tribe *Paniceæ*. A tall erect grass. Stems many, 3-6 ft. high, rooting from some of the lowest joints. Leaves long lanceolate, midrib stout and prominent beneath; ligule very short, truncate ciliate. Spikelets arranged in cylindrical spike-like panicles 6-9 in. long and ¾-1 in. in diameter, each spikelet surrounded by an involucre of yellowish brown bristles, the inner bristles themselves plumose hairy, glumes unequal enclosing 2 flowers, the lower male and the upper hermaphrodite; outer glume minute truncate, inner nearly equalling the pales, retuse. Pales about equal, lower one overlapping the upper, broad, smooth, 5-veined, mucronate, ciliate at the edge. Stamens 3. Style single with a bifid feathering stigma. Seed small, pearl-coloured, smooth.

Varieties. There are two distinct varieties, known respectively as *bájra* and *bájri*, the former with greenish coloured, and the latter with reddish coloured and rather smaller, grain.

Distribution. Bájra is grown very extensively, occupying 19½ lakhs of acres in the 30 temporarily settled N.-W. Provinces Districts, or 8 per cent. of their total cropped area, but it is in great measure confined to the western Districts, and east of Allahabad it is comparatively rare.

Seasons. It is a kharif crop, being sown a little later and reaped a little earlier than juár, and it is occasionally sown on land which was intended for juár, if sowing time be delayed by floods or failure of rain. Its grain is supposed to be heating, and hence is largely consumed by the poorer classes in the cold weather, though it not unfrequently induces diarrhœa. The dry stalks are used as cattle fodder, being, however, vastly inferior to those of juár.

Mixtures. It is rarely grown alone, and is generally mixed with minor crops of much the same kinds as those grown with juár, the place of *múng* in the combination being generally, however, taken by *moth* (*Phaseolus aconitifolius*).

Soils. If juár be taken as the kharif counterpart of wheat, bájra may be still more aptly compared with barley. Like barley it often occupies very good as well as very bad land, but, as a general rule, it is the crop of poor light-soiled outlying land, and requires perhaps rather less rainfall than juár can make shift with. It is never manured, and but rarely irrigated.

The land is ploughed from once to four times, and the seed, mixed with that of the subordinate crops, is sown broad-cast and ploughed in at the rate of 2½ to 3 seers per acre.

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* **References**:—Powell Punj. Prod. 238; Drury Useful Pl. of India 388. *Pennisetum typhoideum*, Rich. *Panicum spicatum*, Roxb.

Weeding and harvesting.

There should be at least one weeding, if possible, but the place of this is often taken by ploughing up the ground between the plants, exactly as is done to juár. The crop should be watched if possible to keep off birds and squirrels for about 20 days before it is cut. The grain ripens towards the beginning of November, when the heads are cut off and carried to the threshing floor, the stalks being frequently left standing on the ground for some weeks. Threshing and winnowing are conducted after the usual fashion.

Diseases and injuries.

Next to an absolute failure of rain bájra suffers most from damp or rainy weather while it is in flower, by which the proper fertilization of the flowers is prevented. The stamens hang outside the flower-envelopes, entirely unprotected from the weather, and it is perhaps to this that bájra owes its peculiar liability to damage from rain. If there is a fall of rain in the beginning of October, it is no uncommon thing to see a bájra field with hardly a single grain formed on its spikes. It suffers still more than juár from the miçroscopic fungus known to English farmers as "bunt," and is reported to be often infected with a species of mildew called *bagulia* (*Puccinia sp.*) which manifests itself first in spots on the foliage, and then in total destruction of the grain. But it owes in great measure its liability to these diseases to the poverty of the soil on which it is cultivated, and the mildew alluded to above is said to be most destructive in cases where bájra has been grown too frequently on the same land.

Cost of cultivation.

The cost of cultivation is given below:—

	Rs.	As.	P.
Ploughing (twice), ...	1	8	0
Clod crushing (twice), ...	0	4	0
Seed, ...	0	2	0
Sowing, ...	0	13	0
Weeding (by the plough), ...	0	12	0
Watching, ...	0	12	0
Cutting, ...	0	10	0
Threshing, ...	1	8	0
Cleaning, ...	0	3	0
Total, ...	6	8	0
Rent, ...	3	0	0
Grand Total, ...	9	8	0

Outturn.

Authorities agree in showing that the outturn is less in the damper than in the drier parts of the Provinces. For the Meerut and Rohilkhand Divisions 5½ maunds of grain is the highest estimate possible, while in the Agra, Allahabad and Jhansi Divisions 7 maunds of grain does not appear extravagant. The outturn of dry fodder will be in both cases about 30 maunds. If arhar is associated with the bájra, the outturn may be taken as 15 per cent. less. The smaller pulses yield about a maund and a maund and a half per acre.

Area.

The average area under *bájra* and *bájra-arhar* in the 30 temporarily settled Districts of the N.-W. Provinces is shown by Divisions below:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
Bájra.								
Irrigated, ...	3,457	637	3,194	549	117	1,509	199	9,662
Unirrigated, ...	2,26,095	3,84,942	1,87,852	1,29,793	3,944	38,890	2,269	9,73,785
Total, ...	2,29,552	3,85,579	1,91,046	1,30,342	4,061	40,399	2,468	9,83,447
Bájra-arhar.								
Irrigated, ...	920	405	1,978	809	49	1,058	...	5,219
Unirrigated, ...	65,724	2,60,352	3,97,240	2,09,948	3,556	39,983	2	9,76,805
Total, ...	66,644	2,60,757	3,99,218	2,10,757	3,605	41,041	2	9,82,024
Grand Total, ...	2,96,196	6,46,336	5,90,264	3,41,099	7,666	81,440	2,470	19,65,471

No information whatever is possessed concerning the area under bájra in Oudh and the 5 permanently settled N.-W. Provinces Districts.

Explanation of Plate VII.

1. Entire plant with ripe spikes (reduced).
2. Portion of stem with leaf.
3. Spike in flower.
4. Stamens (slightly enlarged).

} nat. size.

5. Ripe spike.
6. Spikelet surrounded by the bristly involucre.
7. Seed.

} nat. size.

PENICILLARIA SPICATA, WILLD.

Drawn by H. Hormusji.

Litho T. C. Press, Roorkee.
Thos D. Bona, *Supdt.*

CICER ARIETINUM, *Linn.*[*]

[*Vide* Plate VIII.]

ENGLISH, **gram**; VERNACULAR, **chana, nakhud** (Persian).

Description. A viscid vetch-like annual belonging to the tribe *Vicieæ* of the papilionaceous division of the natural order *Leguminosæ*. Stems much branched. Leaves 1-2 in. long, pinnate. Stipules small, persistent, leaf-like, obliquely ovate, deeply cut; leaflets 7-8 pairs with usually a terminal one, ovate-oblong or obovate, serrate, prominently veined. Peduncles axillary, 1-flowered, ½–¾ in. long, jointed about the middle, becoming deflexed after flowering; bracts setaceous; calyx tube oblique, teeth about equal, narrow, lanceolate, equally or exceeding the tube. Corolla longer than the calyx, pink blue or white; standard a little longer than the wings and keel. Stamens diadelphous. Pod oblong inflated terminated by the persistent base of the style. Seeds irregularly obovate or sub-globose, beaked, reddish-brown, black, or white.

[*] The botanical specific name owes its origin to a not altogether fanciful resemblance of the seed, when first forming in the pod, to a ram's head. The English name "gram" is applied to a totally different product in the Madras Presidency, where it denotes the seed of the plant known in these Provinces as *kurti* or *guár* (*Dolichos uniflorus*).

Varieties. The varieties ordinarily grown in the Provinces may be for the most part thrown into two classes, large grained and small grained, the former of a markedly reddish, and the latter of a light brown, colour. A black grained variety is not uncommon, and there is a very large white grained kind known as "Cabuli," which has hardly found its way into ordinary cultivation, and is grown more as a curiosity than for profit. It requires higher cultivation than the common varieties, and is said to closely resemble a kind which is an important crop in Spain, and under the name of *Garbanzos* is used, plainly boiled, as one of the commonest articles of food.

Distribution. Gram is one of the most characteristic crops of the Provinces, being grown either alone or mixed with other crops, on about 42¾ lakhs of acres in the 30 temporarily settled N.-W. Provinces Districts, which is about 17 per cent. of their total cropped area. Its cultivation is tolerably evenly distributed throughout districts west of Allahabad, east of which it shows a considerable decrease. Sown alone or mixed with wheat or barley it forms the chief crop of the poorer classes of soils, and follows next after wheat and barley in the extent of the area which it occupies.

Seasons. Gram is a rabi crop, and is the earliest sown of the number, not being damaged by the heat of the end of September and beginning of October, as are the more strictly temperate crops. It is sown from the middle of September to the middle of October, and has therefore more chance than either wheat or barley of finding a moist seed bed, and it is harvested in April.

As a general rule it is grown on land which lay fallow during the preceding kharif, but in Rohilkhand and Oudh it is very commonly grown as a second crop after early rice, the area double cropped in this manner in the Gonda District being reported to be in some parganas fully one-half of the total.

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[*] **References**:—Hook. Fl. Ind. ii. 176; Roxb. Fl. Ind. iii. 324; Wight Ic. t. 20; W. & A. Prod. 235; Drury p. 134; Powell Punj. Prod. p. 240.

Mixtures. Roughly speaking for one acre of gram sown alone there are over two acres under gram and barley, and nearly two acres under gram and wheat. In Rohilkhand, Oudh and Bundelkhand, linseed is very extensively grown in gram fields, while in the Doáb very few gram or gram-barley fields will be found without an admixture of *duán* (*Eruca sativa*) or rape. Crops which also very commonly enter into the mixture in gram-barley fields are peas and the coarse pulse known as *kassar* or *kesári* (*Lathyrus sativus*).

Soils and manuring. Gram is grown on all soils from the heaviest clay to the lightest loam, but it is on the former class of soils that it yields its highest produce, and it is therefore on them most frequently grown alone; on light soils it is generally mixed with barley. It forms, with a small admixture of wheat, the main rabi crop of the heavy black soil of Bundelkhand, and is often found sown in the beds of dry tanks, growing amidst clods of clay too tenacious for the plough to pulverize. Whether on stiff or light soils it appears to be never manured in any way.

Tillage. Unlike wheat and barley it does not require a fine tilth, and the ploughings which gram fields receive (ranging from 12 in Rohilkhand to 4 in Bundelkhand) are rather to prepare a deep than a well pulverized seed bed. In no case are the clods broken by the use of the log clod crusher.

Sowing. It is sown at the rate of 80 to 100 lbs. to the acre, broad-cast in Rohilkhand and parts of Oudh, but drilled behind the plough in most of the drier Districts. It is reported to be not altogether uncommon in the Bareilly District to sow it without any previous cultivation whatever, scattering the seed on the untilled ground and then ploughing it in.

Irrigation. It is hardly ever irrigated when grown alone, nor is the mixture of gram and wheat which forms the staple crop of Bundelkhand. From $\frac{1}{3}$rd to $\frac{2}{3}$ths of the area under gram-barley is watered, but not as a rule more than once, or, at most, twice.

Weeding. A weeding is very seldom given, but a common practice is to cut back the plants before they flower, by picking off the tops of the shoots, which are much relished as a vegetable (*ság*), the flavour being possibly enhanced by the oxalic acid which it is the curious property of the leaves to exude. This topping renders the plants strong and bushy, and increases the outturn of grain.

Harvesting. Harvesting and threshing are in no way different from those in the case of wheat or barley.

Diseases and injuries. It suffers greatly from frost, if caught by it in flower, and whole fields of healthy plants are sometimes ruined by a cold night in January or February. Great injury also often results from the ravages of a caterpillar well known to natives as the *bahádura*.

Cost of cultivation. The cost of cultivation may be stated as below:—

	Rs.	A.	P.
Ploughing (four times), ...	3	0	0
Seed (80 lbs.), ...	2	0	0
Sowing, ...	0	14	0
Reaping, ...	1	9	0
Threshing, ...	2	0	0
Cleaning, ...	0	6	0
Total, ...	9	13	0
Rent, ...	3	0	0
Grand Total, ...	12	13	0

The approximate average outturn per acre of unirrigated gram, gram-barley and gram-wheat is shown below :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division.	Benares Division.	Jhansi Division.	Kumaun Division.	Oudh.
Gram, ...	8	8	5	6	7	7	8	7
Gram-barley, ...	9	9	6	7	8	7	9	8
Gram-wheat, ...	9	9	6	7	8	7	9	8

The outturn is highest in tracts where winter rains are of tolerably regular occurrence, and is lowest in the Agra Division, the average for the Allahabad Division being raised by its including two Districts of Bundelkhand. The outturn of gram-barley and gram-wheat have been put at the same figure, since although the yield of gram-barley would be largest on similar soils, it is, as a rule, grown on poorer land than gram-wheat.

For irrigated land an all round average may be assumed of 12 maunds for gram alone, 14 maunds for gram-barley, and 13 maunds for gram-wheat; when irrigated, gram-wheat and gram-barley are grown on similar soils, and the outturn of the latter has therefore been assumed the largest.

In the outturn of a gram-barley field, gram does not, as a rule, amount to more than $\frac{2}{3}$ths of the total; when sown with wheat it constitutes about $\frac{1}{3}$rd of the outturn, except in the Allahabad and Jhansi Divisions, where it rises as high as $\frac{2}{3}$rds, since in Bundelkhand Districts wheat takes a very subordinate part in the mixture.

The outturn of straw is in weight about 25 per cent. more than that of grain. Gram-*bhúsa* is considered a most excellent food for cattle, but is seldom given alone, being generally used to give a flavour to more unpalatable fodders.

Area.

The average area under gram and its mixtures in the 30 temporarily settled N.-W. Provinces Districts is shown by Divisions below :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Gram.								
Irrigated, ...	23,764	8,028	14,787	4,377	23,725	2,792	480	77,953
Unirrigated, ...	2,31,983	2,23,256	1,10,247	3,61,665	66,814	92,207	3,893	10,90,065
Total, ...	2,55,747	2,31,284	1,25,034	3,66,042	90,539	94,999	4,373	11,68,018
Gram-barley.								
Irrigated, ...	1,67,579	13,395	3,63,297	1,89,313	90,865	4,812	6	8,29,267
Unirrigated, ...	2,76,781	1,13,316	3,83,619	4,81,908	60,068	32,334	504	13,48,530
Total, ...	4,44,360	1,26,711	7,46,916	6,71,221	1,50,933	37,146	510	21,77,797
Carried over, ...	7,00,107	3,57,995	8,71,950	10,37,263	2,41,472	1,32,145	4,883	33,45,815

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Brought over, ...	7,00,107	3,57,995	8,71,950	10,37,263	2,41,472	1,32,145	4,883	33,45,815
Gram-wheat.								
Irrigated, ...	43,089	3,144	40,824	12,465	700	4,359	4	1,04,585
Unirrigated, ...	95,219	26,808	35,985	3,50,933	525	3,10,665	410	8,20,545
Total, ...	1,38,308	29,952	76,809	3,63,398	1,225	3,15,024	414	9,25,130
Grand Total, ...	8,38,415	3,87,947	9,48,759	14,00,661	2,42,697	4,47,169	5,297	42,70,945

The figures shown under the heads "gram-wheat" and "gram-barley" have also been included in the statistics of area given in the notices appropriated to wheat and barley. No statistics of area are available for Oudh or the N.-W. Provinces permanently settled Districts.

Explanation of Plate VIII.

1. Upper part of plant.
2 & 3. Flower, front and back views.
4 & 5. Flower with standard and one wing removed.
6. Pod with valves open.

CICER ARIETINUM, L.

Drawn by H. Hormusji.

Litho T. C. Press, Roorkee.
Thos. D. Bone, *Supdt.*

PHASEOLUS MUNGO, *Linn.**

[*Vide* Plate IX.]

ENGLISH, none ; VERNACULAR, múng.

Description.

Natural order *Leguminosæ*, sub-order *Papilionaceæ*, tribe *Phaseoleæ*. A hairy sub-erect annual. Stems about 2 ft. high, branching, angular. Leaves trifoliolate ; stipules ovate acuminate, many nerved ; petioles as long or longer than the leaflets, channelled ; leaflets 2-4 in., entire or more or less lobed, terminal one ovate acute, cuneate at the base, lateral one rhomboid ovate, rounded at the base, hairy on both sides ; stipels narrowly lanceolate, sub-persistent. Flowers about 6, crowded, in axillary racemes ; peduncles short. Calyx about ⅛ in., broad and more bifid above, lower portion longer and pointed. Corolla about ½ in. long, yellow ; keel beaked, spirally twisted. Stamens diadelphous. Pods 2-2½ in., sub-cylindrical, pointed, silky, 8-12-seeded. Seeds small, green yellow or black.

Varieties.

Múng is one of four pulses which resemble one another very closely in appearance and habit of growth, the other three being *urd* (or *másh*), *lobia* (or *rausa*, *rawás*) and *moth*. Múng is the most valuable of the four, and, as a rule, its consumption is confined to the better classes of natives. It can be easily distinguished from either moth or lobia, but its resemblance to urd is so close, that both are considered by some botanists varieties of the same species. The most popular distinction between the two plants in the field lies in múng having dark green and urd yellowish green leaves, but the principal difference is in the shape of the grain, in that of urd being much larger and longer than that of múng. Exclusive of urd there are three well marked varieties of múng, having respectively green, yellow and black seeds. The green seeded is the typical and commonest variety, that with yellow seed (known as *sona* or golden múng) being named *Phaseolus aureus*, and that with black seeds *Phaseolus Max*.

Distribution and Seasons.

Múng is grown in every District of the Provinces, but almost invariably as a subordinate crop in fields of millet or cotton, and very seldom by itself. It is therefore a kharif crop, being sown at the commencement of the rains and reaped in October. It is in some respects remarkable that it is not more frequently grown alone, since its grain commands a far higher price than that of millet, but this is no doubt partly explained by the precariousness of its growth, heavy and continuous rain, especially in September (when it is in flower), often causing absolute ruin. But as a counterpoise to this it bears, and justly, the reputation of being able to withstand a great deal of drought, and in a season of scant rainfall when millets have utterly failed, it, with urd, lobia and moth, forms a most valuable food resource, the so-called "subordinate" crop becoming in this case of first rate importance. Another advantage which these pulses share with arhar is that of not impoverishing the soil, or at all events not to the extent of gramineous crop such as the millets. Not only does the depth to which their roots penetrate enable them to gain moisture from land on which their shallow rooted companions wither of drought,

* **References**:—Hook. Fl. Ind. ii. 203 ; Roxb. Fl. Ind. III. 292 (seeds green) ; W. & A. Prod. 245 ; Powell Punj. Prod. 239 ; Drury Useful Pl. of Ind. 337. *Ph. Max.*, Roxb. l.c. 295 (seeds black). *Ph. aureus*, Ham. (seeds yellow).

but it also leads to the aëration of the ground, and whether it be true or no that they actually add to the fertility of the soil by fixing atmospheric nitrogen, they at all events increase the fertility of its surface by accumulating from below food substances which were beyond the reach of shallow rooted plants.

Method of cultivation.

Its cultivation is exactly the same as that of cotton or millet. When grown alone it is sown at the rate of about 12 seers to the acre. When associated with millet or cotton it shares the benefit of the weeding which these crops receive, and only receives irrigation when they require it. It is reaped about a fortnight before the millets, and is threshed out by bullocks in the usual manner. The crushed stalks and leaves are much prized as fodder, and are used to give a tempting flavour to trash that even Indian cattle might otherwise reject as uneatable.

Harvesting.

Cost of cultivation.

Its cost of cultivation may be assumed to be the same as that of juár or bájra.

Average outturn.

When grown alone the average outturn per acre is reported from most districts as about 5 maunds of grain and three times this weight of fodder.

Area.

The area returned as being under múng alone during 1881, in the 30 temporarily settled Districts of the N.-W. Provinces, is shown by Divisions below :—

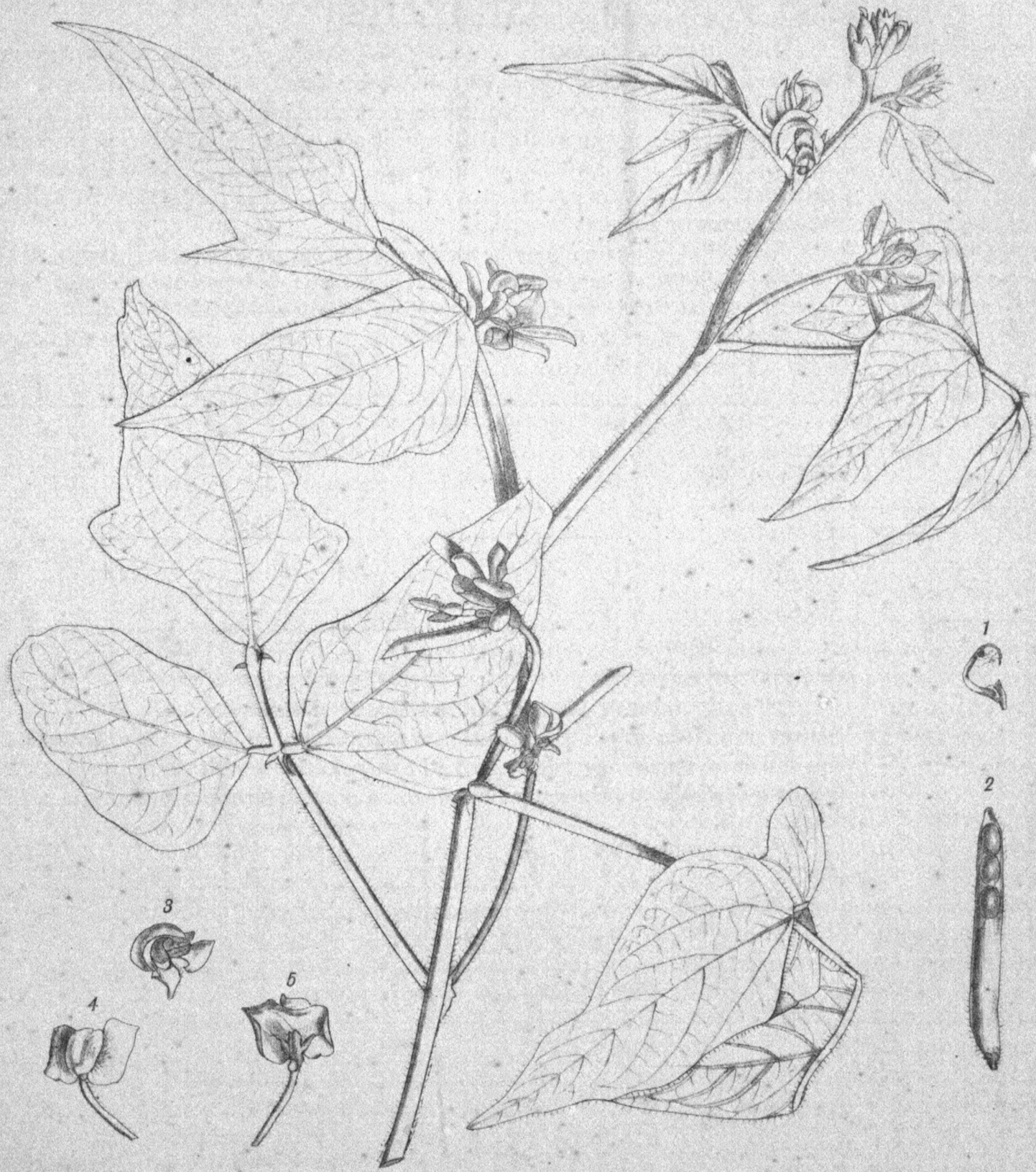
	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	86	239	33	72	...	52	...	482
Unirrigated, ...	8,170	14,996	1,955	1,285	49	2,747	...	29,202
Total, ...	8,256	15,285	1,988	1,357	49	2,799	...	29,684

These figures give, however, no real idea of the part played by múng in the agriculture of the country. In greater or less amount it is grown on fully one-fourth of the total area under kharif crops in the Provinces, and represents so to speak the cultivators *insurance* against a shorter allowance of rainfall than his millets can make shift with.

Explanation of Plate IX.

1. Pistil enclosed in the staminal tube, spirally twisted.
2. Pod with portion of one valve removed to show the seeds.
3, 4, & 5. Side, front, and back views of flower.

} all nat. size.



PHASEOLUS MUNGO, L.

Drawn by H. Hormusji.

Litho. T. C. Press, Roorkee.
Thos. D. Bona, *Supdt.*

PHASEOLUS RADIATUS, *Linn.**

[*Vide* Plate X].

ENGLISH, none; VERNACULAR, urd, másh.

Description. A variety of *Ph. Mungo*, from which it differs in having longer and more trailing stems; the whole plant too is much more hairy, the reddish brown pubescence giving the foliage a lighter tint; the seeds are fewer, larger and longer than those of *múng*, and usually of a dark brown colour.

Varieties. The close resemblance of *urd* to *múng* which has induced some authorities to include them both in one species has been already mentioned. Urd has, however, two distinct sub-varieties of its own, one with large black seeds ripening in August and September, and the other with smaller green seeds ripening in October and November. The latter is sometimes given the diminutive name of *urdi*.

Distribution. It is grown commonly throughout the Provinces generally as a subordinate crop with millet or cotton, but more often by itself than either múng or lobia. The total area under urd in the 30 temporarily settled N.-W. Provinces Districts is returned as 2,58,495 acres, being 1 per cent. on the total cropped area. Its cultivation as a sole crop reaches the maximum in the Meerut, Rohilkhand and Benares Divisions, as is shown in the appended table:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Percentage of area under urd alone to total kharif cropped area, ...	3·6	4·7	·2	·2	1·4	1·2	3·1

The Meerut, Rohilkhand and Benares Divisions are the principal sugar-cane tracts in the Provinces, and the comparatively large area under urd which they return may be due to the fact that urd is one of the few crops which can be grown before sugar-cane without greatly lessening the produce. It only occupies the ground for a short time in the rains, and is reported to leave the soil as rich in food substances as it found it.

Seasons. It is sown at the commencement of the rains, and ripens, one variety in August and September, and another in October and November. A rare custom is reported from the Cawnpore District, under which it is grown as a spring crop, being sown on damp low-lying ground in February and reaped in May.

Method of cultivation. Its cultivation is precisely similar to that of the autumn millets or cotton. When grown alone it is sown broad-cast at the rate of from 4 to 6 seers per acre. It thrives

* Roxb. Fl. Ind. iii. 296. *Ph. Mungo*, Linn. var. *radiatus*, Hook. Fl. Ind. ii. 203. *Ph. Roxburghii*, W. & A. Prod. 246; Powell Punj. Prod. 239; Drury Useful Pl. of Ind. 338.

best on the heavier classes of soils, and differs in this respect from múng, which prefers light sandy ground. It is harvested similarly to múng, and the fodder afforded by its stems and leaves forms no unimportant portion of its produce. The plants suffer greatly from mildew if there is a long continuance of damp winds from the east, and the flowers are reported to be often damaged by thunderstorms, by the lightning as popularly supposed, but more probably by the heavy downpour of rain which accompanies it.

Its average outturn per acre when grown alone is about 5 maunds grain with three times this weight of straw. When grown with other crops its outturn varies enormously, since it is not sown in any definite proportion. In seasons of good rainfall it is often choked by the luxuriant growth of its principal crop, but when rain is scanty or ill-timed, it comes to the fore and contributes the greater proportion of the outturn.

Area. The following table shows the average area under urd alone during the past three years in the 30 temporarily settled N.-W. Provinces Districts:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	2,614	126	68	178	6,898	20	160	10,064
Unirrigated, ...	87,369	1,12,142	4,375	5,092	27,007	8,750	3,696	2,48,431
Total, ...	89,983	1,12,268	4,443	5,270	33,905	8,770	3,856	2,58,495

This represents, however, but a very small fraction of the total area on which urd is grown, and if the area be included on which it is sown as a subordinate crop, the total would be at least twelve times as large as this. No statistics are available respecting the area under urd in Oudh and in the 5 permanently settled N.-W. Provinces Districts.

It may be mentioned that the seed of urd (or *máṣh*) is the reputed origin of the weight known as *másha*, twelve of which go to the tola, and 960 to the seer.

Explanation of Plate X.

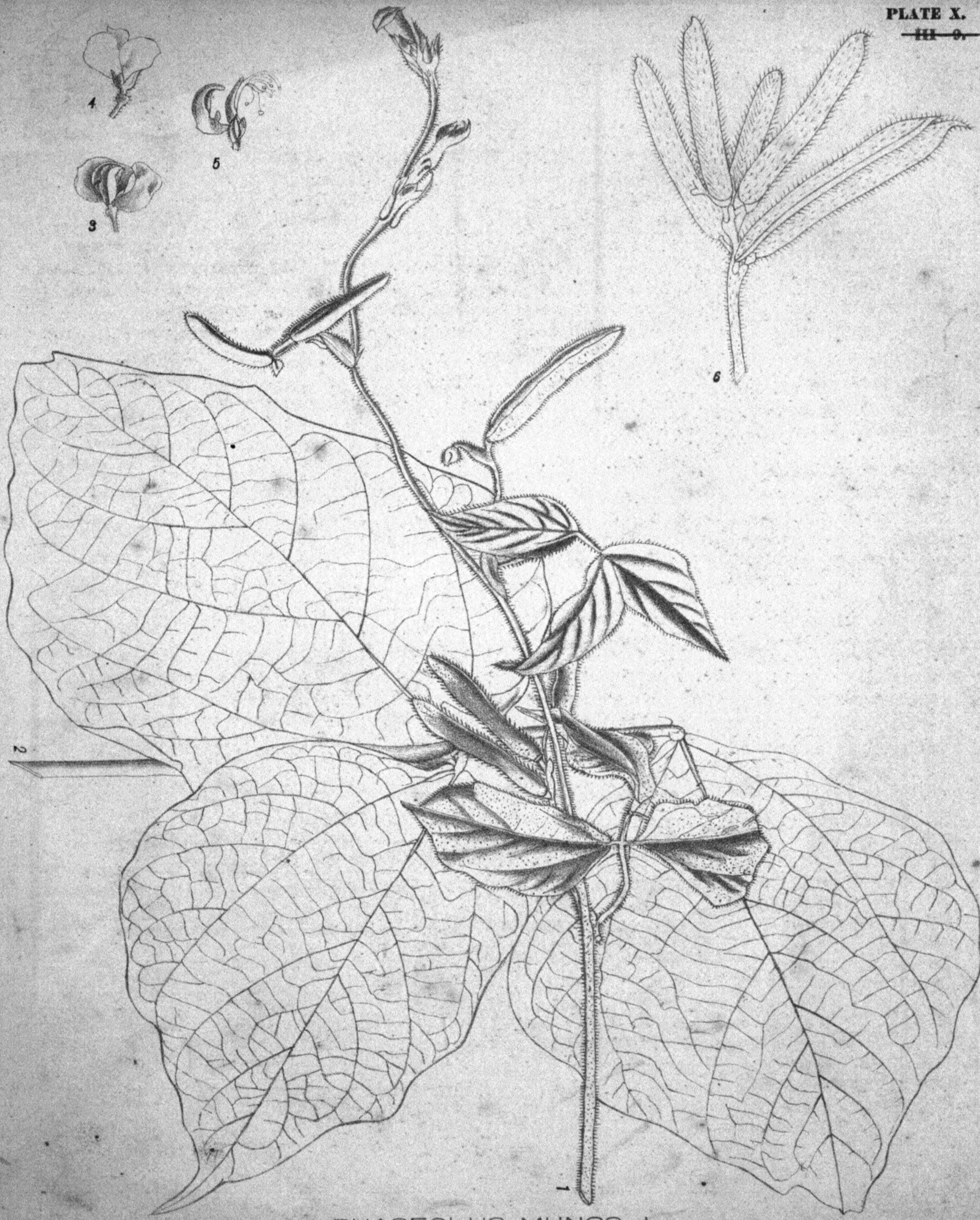
This plate should have been arranged so as to have been looked at lengthways in order to show the trailing habit of the plant.

1. Flowering extremity of plant,
2. Single leaf,
3 & 4. Back and front views of flower,

} nat. size.

5. Side view of flower with standard and wings removed,
6. Raceme of pods,

} nat. size.



PHASEOLUS MUNGO, L.
VAR. RADIATUS.

Drawn by H. Hormusji.

Litho T. C. Press, Roorkee.
Thos. D. Bate, *Supdt.*

PHASEOLUS ACONITIFOLIUS, *Jacq.**

[*Vide* Plate XI.]

ENGLISH, none; VERNACULAR, **moth, mothi.**

Description.

Natural order *Leguminosæ*, sub-order *Papilionaceæ*, tribe *Phaseoleæ*. A diffuse hairy annual. Root perpendicular. Stems several, extending many feet along the ground in every direction, angular, and with a few scattered hairs. Leaves trifoliolate; stipules cohering, ovate lanceolate; petioles a little longer than the leaflets; stipels subulate; leaflets deeply 3-lobed, the upper ones more finely cut. Peduncles axillary, nearly as long as the petioles, ending in an oblong glandular head of small yellow shortly pedicelled flowers; bracteoles twice as long as the calyx, subulate, ciliate; calyx-tube campanulate, lowest tooth longer than the rest, the two upper connate; keel with stamens and style spirally twisted. Pod 1½-2 in., straight, cylindrical, torulose, smooth. Seeds small, oblong, light brown; hilum linear, whitish.

Varieties.

Moth in the kharif answers to the coarse pea, known as *kesári*, in the rabi, both being grown on the worst land which can be made to bear a crop. It is in consequence grown much more commonly as a sole crop than either *múng* or *lobia*, and the area which it occupies on its own account is very nearly equal to that under *urd*. It also forms a very common mixture in millet fields, especially in the case of the spiked or bulrush millet (*bájra*), which it resembles in its preference for light sandy soils, and also in its liability to damage from ill-timed rainfall.

Cultivation.

Its cultivation when grown alone is of the roughest possible description. A couple or at most three ploughings are held sufficient, and the seed is sown broad-cast at the rate of 4 seers to the acre.

Seasons.

In a favourable season its produce is often very heavy, but taking into consideration the poverty of the land on which a great portion of it is grown, and its liability to damage from rain while in flower, the highest outturn of grain which can be taken as the average is 8 maunds to the acre, with rather less than double this amount of fodder. The grain is an article of human food, but there are many prejudices against it, the most notable being that it is liable to produce worms in the bowel. On the other hand it is considered a useful remedy for flatulency. But it is principally used as cattle food, and is said to be a fattening diet, as are also the leaves and stalks.

Area.

Below is shown the average area under moth as a sole crop during the last three years in the 30 temporarily settled Districts, classified by Divisions:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	464	60	484	107	4,762	1	1	5,879
Unirrigated, ...	84,371	67,917	31,504	9,746	10,900	578	1,011	2,06,027
Total, ...	84,835	67,977	31,988	9,853	15,662	579	1,012	2,11,906

* **References**:—Hook Fl. Ind. ii. 202; Roxb. Fl. Ind. iii. 299; W. & A. Prod. 247; Powell Punj. Prod. 240.

Explanation of Plate XI.

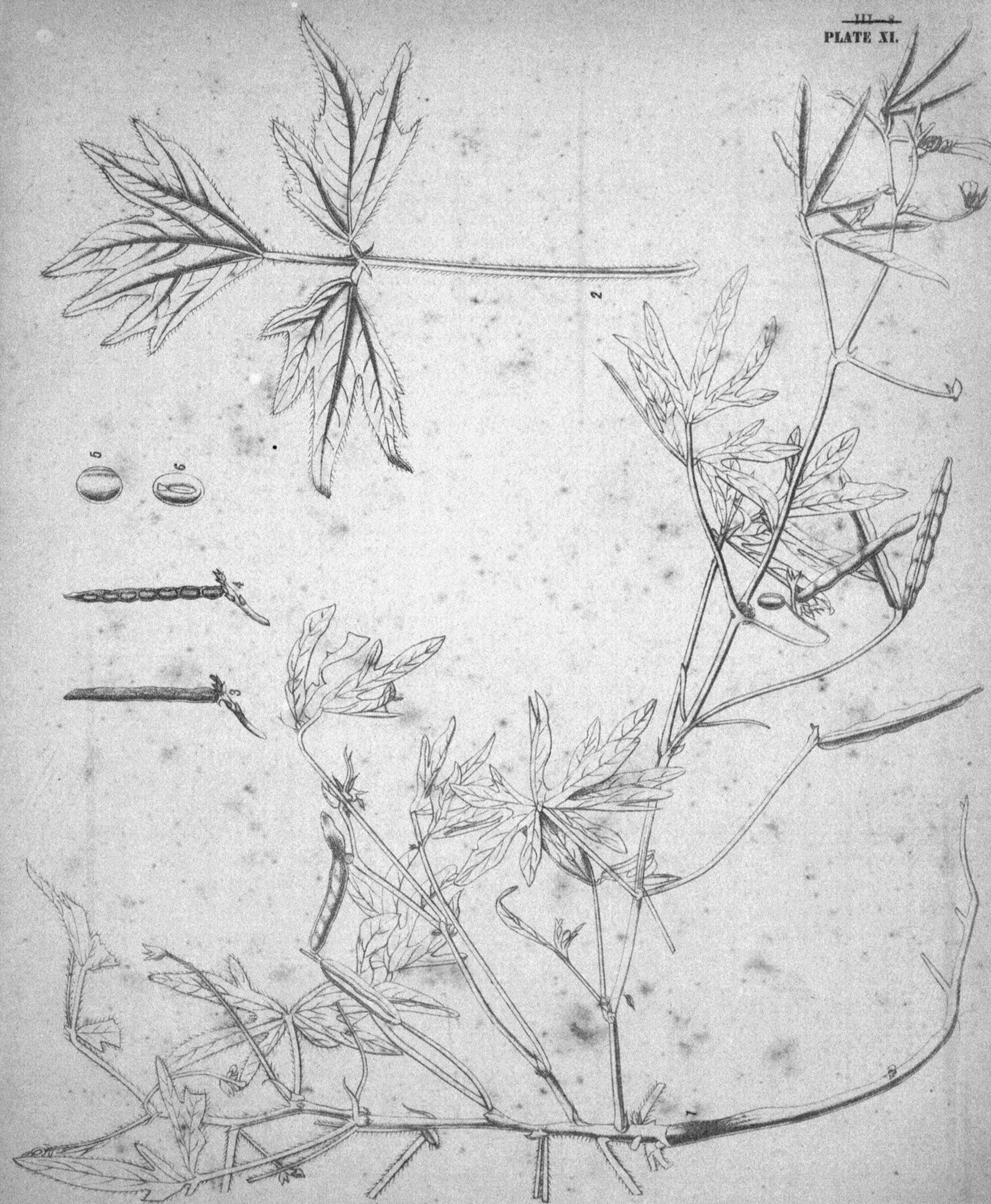
1. Entire plant.
2. A single leaf.
3. A pod.
4. Ditto with one valve removed to show the seeds.

5 & 6. Front and back views of seed.

1—4 nat. size, 5 & 6 enlarged.

This Plate should have had the name printed on the long side.

PLATE XI.



PHASEOLUS ACONITIFOLIUS, JACQ.

Drawn by H. Hermsen.

Litho. T. C. Press, Ecorkco.
Thos D. Bona, *Superit.*

INDIGOFERA TINCTORIA, *Linn.**

[*Vide* Plate XII.]

ENGLISH, indigo; VERNACULAR, nil.

Description.

Natural order *Leguminosæ*, sub-order *Papilionaceæ*, tribe *Galegeæ*. A small shrub, 4-6 ft. high, with silvery, pubescent, tough, angular branches. Leaves alternate, 3-4 in. long, with minute subulate stipules, unequally pinnate; petiole ½-1 in. long; leaflets opposite, in pairs of 4-6 and a terminal one, shortly stalked, and furnished with minute setaceous stipels, ¾-1 in. long, obovate-oblong or oval, entire, smooth, blueish-green above, and with adpressed white hairs on the lower surface. Racemes stalked, axillary, shorter than the leaves, erect, spikelike, bracts subulate. Flowers small, shortly stalked, rather crowded. Calyx shallow, becoming almost flat, teeth nearly equal, and as long as the tube. Corolla papilionaceous; standard oval, greenish; wings dark pink; keel obtuse, rather longer than the wings, each of the petals spurred at the base. Stamens 10, diadelphous. Pods 1-1½ in. long, straight or sub-falcate; cylindrical, and somewhat contracted between the seeds, 8-12-seeded. Seeds quadrangular, brown.

Varieties.

India is probably the natural habitat of the indigo plant, and the origin of the name which it bears in Europe. Several species are found either wild or cultivated, in addition to the one commonly grown in these Provinces, the most noticeable being the wild indigo of the Himalayas (*Indigofera atropurpurea*), which forms a dense undergrowth in many localities on the outer ranges of the Himalayas between 2,000 and 6,000 feet. This species is not reported to yield dye matter, but another species (*I. Anil*, Linn) which is cultivated in the Madras Presidency affords a dye similar to that of *Indigofera tinctoria*. No varieties of *Indigofera tinctoria* are reported to exist in these Provinces, but some would probably be discovered by careful investigation.

Distribution.

The distribution of indigo cultivation in these Provinces appears to be very capricious. It is of course entirely dependent on the existence of factories for the extraction of the dye, and indigo manufacture is very far as yet from having spread over the whole tract suited to it, but is to a great extent concentrated in localities where it was first started by the enterprise of European grantees or settlers. The following sketch of the rise of indigo manufacture in the Azamgarh District is taken from Mr. Reid's Settlement Report, and its outline will apply with almost equal force to any other District in the Provinces:—

"The manufacture of indigo for export dates from the early years of British rule in the district. The "Company's commercial resident was allowed to trade on his own account as well as for his masters, and "Mr. Crommelin, commercial resident at Azamgarh and Mau, in company with two gentlemen named Stewart "and Scott, started the first indigo concern in Azamgarh. Its establishment was opposed by the Magistrate "of the district under the rule which forbade the Europeans to occupy land and engage in indigo manufac-"ture in the ceded Provinces without permission from the Governor General in Council. Mr. Crommelin "eventually got leave to hold the factories, and was exonerated from blame in connection with them, but so "aggrieved did he feel by the action of the Magistrate, that he filed an action in the supreme court for "damages. What the result of the action was the records that are within reach do not show. His indigo "concern seems to have been conducted through European and Eurasian assistants, and at first not without

* **References**:—Linn. Sp. Pl. Ed. I. p. 751; Roxb. Fl. Ind. iii. 379; W. & A. Prod. 202; Fl. Brit. Ind. ii. 99; Bentley and Trimen Med. Pl. 72; Brandis For. Fl. 185; Powell Punj. Prod. 489; Drury Useful Pl. of Ind. 254.

"disputes with the Natives, which the latter were careful to bring to the notice of the Magistrate. The "prohibitory rule under which Mr. Crommelin had been opposed did not apply to persons born in India, and "soon after the establishment of his concern others were set agoing in various places. In 1808 Mr. D. O. "Fergusson, acting on behalf of a Major Stevenson, erected a factory at Nizamabad, and another, now fallen "completely to ruin, was established at Imilia, which though professedly the property of a native, was in 1811 "managed by an European of the name of O'Dell. And as time went on, more small factories were erected "at various places. In 1812 Mr. Fergusson's factories passed into the hands of Mr. J. Sturmes. This "gentleman carried on the concern vigorously, and added to it another branch factory. He also engaged "with sugar and cloth trades, and by mortgage, purchase and farm held possession of a number of landed "estates. After his death in 1821, his indigo concern and estates were managed for a number of years by "his executors. In 1829 the indigo concern and part of the estate were sold, the former being purchased by "Mr. H. E. Hunter. Meantime Mr. Crommelin's factories had changed hands, some being held by persons "resident in the district, others by persons resident in Calcutta or elsewhere who managed them through "agents. For several years after 1829 Mr. Hunter, who in addition to the Nizamabad concern, had taken "over some of the factories erected by Mr. Crommelin and others, and Mr. J. H. Stonehouse, who held the "Dohrighat concern, were the chief independent Europeans in the district. They traded largely in sugar "and other native produce in addition to indigo, and Mr. Hunter was also in possession of a good deal of "landed property. He died at Nizamabad in 1845, and his large indigo concern was broken up. Mr. "Stonehouse also had been unfortunate in business, and had to relinquish most of his factories, but he con- "tinued to reside in the district, holding a small factory which he built at Rajapatti in pargana Nizamabad "till 1857. At the time of the mutinies there were at least nine concerns whose head quarters were in the "district. The chief of these was the Dohrighat concern held by Mr. E. F. Venables. Previous to the "mutinies, and for some years after them, the production of indigo remained chiefly in European and Eurasian "hands. The only native who seems to have held factories before the mutinies was Basu Darzi, who having "originally been Mr. Hunter's tailor, and afterwards his chief manager, had acquired a good deal of money, "and on Mr. Hunter's death purchased six of his factories. But about 12 or 15 years ago natives began to "take an interest in the trade, and the comparatively high prices of 1864 and the following years brought "about among them a rage for factory building. Numbers of new native factories sprang up. Of 415 factories "now standing in the district, 323 have been built during the last 14 years. At the present time only 29 "factories, with 115 pairs of vats, are the property of, or held by, Europeans and Eurasians. The rest (386 "factories, with 607 pairs of vats) are the property of, or held by, Natives."

The total area under indigo in the N.-W. Provinces and Oudh may now be put at 2,89,000 acres. Some details concerning the number and size of the factories in work are given at the end of this notice, but it may be mentioned here that one of the principal obstacles to the increase of indigo production is the great prejudice which exists against it in many parts of the country, based either on semi-religious objections to growing the plant, or on a dislike to the relations between cultivator and factory to which it leads, and which will be noticed more fully further on.

The percentage of the area under indigo to the total cropped area and to that cropped in the kharif season in each temporarily settled Division of the N.-W. Provinces is shown below :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Percentage of area under indigo—							
to total kharif crop area, ...	4·2	·1	3·7	1·7	·8	...	...
to total crop area, ...	2·0	...	2·0	·9	·4	...	...

It is noticeable how small is the footing which the plant has obtained in Rohilkhand, and in Oudh its cultivation is still more rare, although the soil and climate of both tracts are probably as well suited to its growth as those of the Eastern Districts, in which the best indigo of the Province is produced. The indigo cultivation of the Benares Division is conducted entirely with well or tank irrigation, and is a continuation of the indigo tract of Behar, the most productive in India. West of Allahabad indigo follows the canal; thus in the Agra Division the canal irrigated Districts of Etáwah, Etah, Mainpuri, and Farukhabad, have an area under indigo amounting respectively to 4·6, 2·3, 2·7 and 1·9 per cent. of their total cropped area, while the Districts of Muttra and Agra, which until lately received no canal water, show only ·3 and ·9 per cent. Similarly Cawnpore, the only canal irrigated District in the Allahabad Division, has 4·0 per cent. of indigo cultivation, while Fatehpur its next door neighbour has only ·3, and Allahabad only ·2 per cent.

Seasons. Indigo may be sown either in the spring or at the commencement of the rains. In the first case it is called *jamowa* or *chaiti*, in the second *asarhi*. *Jamowa* indigo is ready for cutting in August, *asarhi* indigo a month later, but whereas land under the former is, as a rule, ploughed up immediately the crop is cut and prepared for a crop in the succeeding rabi season, *asarhi* indigo is left in the ground till the following rains, when it springs up again and yields what is known as a *khunti* or ratoon crop. In the first season after sowing the quality of *jamowa* indigo is much superior to that of *asarhi*, but *asarhi* indigo is said to yield the best crop from ratoons. The *jamowa* system is comparatively new, and has only been adopted in the Azamgarh District since the last 40 years, but is the one commonly followed in the canal-irrigated Districts of the Upper and Middle Doáb. When indigo seed is to be produced the roots of *jamowa* indigo are not ploughed up after the plant has been cut, but they are left in the ground till December, by which time they will have sent up fresh flower-bearing shoots and will yield a crop of seed. The indigo planters of Behar prefer seed imported from these Provinces to that locally grown, and in consequence an extensive trade in it has sprung up, the exports by rail from these Provinces to Bengal amounting in the last three years to 1,12,435 maunds, 1,42,516 maunds, and 1,56,810 maunds, most of which is despatched from the city of Cawnpore. The trade is principally in the hands of Calcutta brokers, who are under contract to supply a certain number of factories with the seed they require, and hence the price of indigo seed is liable to violent fluctuations, ranging from Rs. 6 to Rs. 40 per maund, since a certain amount of seed must be bought whatever be its price, and should the supply run short holders of seed can make their own terms.

Rotation. The *jamowa* system of cultivation is by far the commonest in the Districts west of Allahabad, and unless the roots are left for seed the land almost invariably bears a crop in the succeeding rabi, and is thus twice cropped within the year. The outturn of the rabi crop (wheat or barley) will not be above half what it would have been if grown after a fallow in the rains, but it is only with indigo that this much can be obtained unless the land be manured; the outturn of a rabi crop grown on unmanured land after millet or maize being extremely small.

Mixtures. It is most commonly grown alone, as the period of its growth does not coincide with that of any other crop. Occasionally, however, it is mixed with *juár* or *arhar*, and is

surrounded with a border of castor or *san* (hemp), more with the idea of one crop insuring the other than with any hope of reaping the produce from both.

Soils and manuring. A loam is preferred, but much of the cultivation is on the lightest possible sand, in tracts where copious irrigation is possible from a canal. Manure is very seldom used, but when possible indigo follows sugar-cane or cotton, and reaps some benefit from the manure which was applied to these crops.

Tillage. Four ploughings are held advisable, but the land frequently receives no more than one, especially in canal-irrigated districts, where a prodigal supply of water is often made to take the place of good tillage. For *jamowa* indigo the ground must be watered before ploughing, while *asarhi* fields are not ploughed until softened by the rains.

Sowing. For proper germination of the seeds it is necessary that the seed-bed be thoroughly moist, and this accounts to some extent for the haste made in ploughing. The seed is sown broad-cast at the rate of about 8 seers to the acre, and since it is essential that it be not buried too deeply, it is merely harrowed in by the log clod-crusher or by a bush.

Irrigation. The number of waterings which are given to *jamowa* indigo between the date of its sowing and the commencement of the rains varies with the dryness of the air, being as many as six in Cawnpore, two in Bareilly, and only one in Azamgarh. *Asarhi* indigo requires no watering in a year of ordinary rainfall.

Weeding. It is essential that the crop be kept free from weeds, and two weedings are the least that are given.

Harvesting. The plant is ripe for cutting just before it flowers. It is reaped with sickles in the ordinary way, and is carried to the factory, where the process of extracting the dye at once commences. The essential parts of an indigo factory are (1), two sets of vats one on a lower level than the other, the upper set being used for steeping the plant, and the lower set for concentrating the dye matter; (2), a boiler and furnace for boiling the dye; and (3), an apparatus for straining and pressing. The size of the steeping vat varies, but it is usually large enough to contain from 50 to 100 maunds of plant. The plant is packed into the vat, which is then filled with water, the plant being kept submerged by some cross bars which are fitted across the vat above it. The time during which this steeping continues varies according to the weather from 11 to 15 hours, being less in muggy damp weather with the wind in the east, than when the air is dry with a west wind. It is of great importance, however, that the steeping should be stopped at the right moment; if underdone, dye matter is lost, and if unduly prolonged, the quality of the produce suffers.

The steeping vat opens by a channel into the vat which corresponds with it in the lower tier, and when the steeping is finished, a plug is drawn and the water drained off into the lower vat, leaving the plant behind it, which can then be thrown aside. The water is of a greenish colour, and is charged with a substance known as indican, which fermentation has extracted from the plant leaves. In order to convert this substance into indigotine, the basis of indigo dye, it is necessary to oxidize it, and the next process known as "beating" has this for its object. Usually it is performed by 7 or 8 men who stand in the vat and agitate the liquid either with their hands or with a rake-shaped paddle. As the oxidation proceeds, dark blue particles of indigotine (known collectively as the fecula) appear in the liquid, which changes in colour from green to blue. The process is con-

tinued for from 1½ to 3 hours, and may be stopped so soon as a little of the liquid placed in a saucer readily throws down a dark blue precipitate remaining itself of a clear sherry tint. It is now allowed to stand until the fecula has settled, which takes place in about a couple of hours, and is sometimes assisted by pouring some cold water into the vat. The surface liquid is then carefully drained out of the vat by holes which have been made in its walls for the purpose, and the dark blue sediment which remains is conducted along a masonry channel into the boiling vat, where it is kept over a moderate fire for about 5 hours, and is then repeatedly passed through a cloth strainer, which effects the separation of the dye particles from the water. The dye matter is then allowed to lie on the strainer until partially dry, when it is carried to the press and placed in boxes with moveable sides, in which it is subjected to gradually increasing pressure for about 12 hours, at the end of which time it will have taken the form of firm slabs 3½ inches square, which are then cut into cakes of the same length, and are ready for being stamped and finally dried. The whole process from plant to cake occupies therefore about 48 hours, and at a large factory one follows the other in constant repetition for some 45 days in August and September. Good indigo cake should contain about 50 to 60 per cent. of indigotine; it should be bright, of a dark blue colour, with a coppery gloss, breaking with an evenly coloured fracture; it should not part with its colour by light friction.

The outturn of indigo from plant varies with the season from 2½ to 4 per thousand, being highest in years of moderate or light, and lowest in years of heavy rainfall.

The prices which N.-W. Provinces indigo commands in the Calcutta market vary from year to year between very wide limits. In very few cases does the price come within 20 per cent. of that obtained by Tirhoot cake, and of N.-W. Provinces produce that of the Benares Division is considered the best, facts which indicate the greater suitability of the climate of the Eastern Districts for indigo manufacture. The average price of the N.-W. Provinces indigo is further kept down by the very large proportion formed by native made cake, which sells at a much lower price than that made under European supervision. Almost the whole of the cake exported from Tirhoot is returned as of European manufacture, which is the case with only 13·5 per cent. of the N.-W. Provinces indigo. The average prices per factory maund of 74 lbs. 10 oz. obtained by N.-W. Provinces and Tirhoot indigo during the last three years are given below :—

	1879.	1880.	1881.
N.-W. Provinces—	Rs.	Rs.	Rs.
Doáb, ...	227	175	200
Benares Division, ...	261	210	240
Tirhoot, ...	287	245	260

The cost of manufacture (including price of plant) is much higher for European than for Native factories, being about Rs. 125 per maund in the former, and Rs. 85 in the latter case.

Thus far of indigo manufactured for export. A large proportion, however, of the indigo intended for local consumption is manufactured much more roughly, all boiling being dispensed with, the cake being known in this case as *gádh*,—the *gaud* of the Calcutta market. The factory in this case merely consists of a few masonry vats sunk in the ground. The process is substantially the same as that described above, except that in the steeping vat fermentation is artificially excited by the addition of gum

or sugar, which is said to deteriorate the quality of the cake, but which forms the basis of a process recently patented by a European planter, by which the amount of dye matter extracted is said to be increased by 25 per cent. But the manufacture is conducted as a rule in a slovenly manner, and the dye not properly strained or cleaned, although the resulting *gádh* seems suited to the requirements of country dyers. It is occasionally purchased by the larger factories and worked up into pucka (or boiled) indigo cake.

The extension of canal irrigation seems leading to a great increase in the number of indigo factories. The construction of new factories appears, however, to be now confined to native enterprise, and the annual fluctuations in the number worked by Europeans indicates merely the occasional extension of operations to outlying branch factories, which return no profit except in favorable years. An indication of the extent of indigo manufacture during the last two years is furnished by the following figures:—

Year.	European or Native.	Number of factories working.	Number of vats in use.	Amount of plant used.	Approximate outturn of dye, (in factory maunds).
1880	European, ...	156	1,352	24,83,227	8,339
	Native, ...	1,068	6,291	79,70,119	26,413
	Total, ...	1,224	7,643	1,04,53,346	34,752
1881	European, ...	176	1,366	34,10,278	9,610
	Native, ...	1,328	7,574	1,61,82,348	36,334
	Total, ...	1,504	8,940	1,95,92,626	45,944

The relations between factory and cultivator are such an important feature in the agricultural conditions of the Provinces, that some notice of them here may not be out of place. In some instances,—very few in these Provinces,—the plant is grown by the factory direct on land either belonging to it or rented from the proprietors or cultivators for the purpose. But the system usually followed is for the factory to purchase the plant from cultivators, at a price which may be fixed either when the crop is sown, or when it is ready for delivering. When the first factory is started in a district, it is evident that no cultivators will grow plant unless assured before hand of its purchase at a fair price, since, the crop being useless to him unless taken by the factory, the latter could make its own terms if no agreement was come to before the plant was on the ground. This was very possibly one of the causes which led to the adoption of the advance (or *badni*) system under which the greater portion of indigo plant is grown. In March or April when the crop is sown the factory binds itself to purchase plant at a price then fixed upon, and the bargain is always clinched if not altogether effected by the factory making an advance in cash to the cultivator, in consideration of which the price to be paid for plant is fixed at a considerably lower figure than what free competition would result in. But so long as the price is not below Rs. 16 or Rs. 18 per 100 maunds, the system is not more objectionable than that followed by Government in furthering opium cultivation. Unfortunately, however, one of the principal objects of the factory in making advances is often not so much to arrange for a crop in the present as to gain such power over the cultivator as will enable it to compel him to grow indigo

on its own terms in the future. Very frequently therefore in the first agreement made with a cultivator the plant is priced at a favorable rate, but a stipulation is entered binding him down to deliver *not less than a certain amount of it which is often knowingly fixed at an impossible figure* on penalty of forfeiting 2½ to 3 times what balance there may be against him. With the chance of obtaining cash down, the cultivator pays but little heed to stipulations of a merely contingent nature, and hence a single bad season may involve him in obligations to the factory, and—in the experience of the Bareilly District—"henceforward he has no resource if he wishes to get free of debt but emigration or rather flight to the Terai—that safe haven of refuge from civil court decrees."

The power thus acquired over a cultivator may be used either to compel him to grow plant at the factory's will, or to sell his plant at a price much lower than it would otherwise command. That these are solid advantages may be judged from the fact that the value of a factory is often estimated by the amount of outstanding debts it has, or in other words, by the degree to which surrounding cultivators are under obligations to it.

With an increase in the number of factories in a district the market for plant becomes of course much wider, and it then becomes possible for a cultivator to grow indigo unfettered by agreements and to rely for obtaining a good price on the competition of one factory against another. This is the system known as the *khushkharid* or "good bargain," so named of course from the cultivator's point of view. In a district where factories are numerous, the difference between the price paid for *badni* and *khushkharid* indigo is very great; when the former is contracted for at Rs. 18 the latter will often sell for as much as Rs. 26 per 100 maunds. The *khushkharid* system is of course by far the most popular amongst the cultivating community, and the gradual increase in the prosperity of a village, or its gradual recovery from the effects of a series of disastrous seasons, may often be traced in the increase of the area under *khushkharid* at the expense of that under *badni* plant.

Injuries.

The most dreaded source of damage to the indigo plant is continued wet weather, which renders the plants tall and woody without much foliage, and by a kind of etiolation prevents the proper development of the dye property in the leaves. So much of the indigo grown in the Doáb is protected by canal irrigation, that a year of unduly heavy rainfall is considered even more disastrous than one of partial drought, since a proper allowance of sunlight is as necessary to the production of the dye as water is to the growth of the plant.

Cost of cultivation.

The cost of cultivating an acre of *jamowa* indigo to be cut in August and followed by a rabi crop is shown below:—

	Rs.	A.	P.
Ploughing (twice), ...	1	8	0
Clod crushing, ...	0	4	0
Seed (8 seers), ...	1	8	0
Sowing, ...	0	8	0
Weeding (twice), ...	3	0	0
Reaping, ...	1	9	0
Watering (three times), ...	4	15	0
Total, ...	12	15	0
Rent, ...	2	8	0
Grand Total, ...	15	7	0

Average outturn.

The average outturn of *jamowa* plant may be put at 80 maunds per acre. The outturn of *asarhi* plant will be rather less than this in the first year, but equal to it in the second year. A *jamowa* crop, if the stumps are left in the ground after the stalks have been cut and the land not ploughed up for a rabi crop, will yield an outturn of about 6 maunds of seed to the acre.

Area.

The average area under indigo during 1878, 1879 and 1880 in the 30 temporarily settled N.-W. Provinces Districts is shown below by Divisions:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	1,00,796	2,859	81,035	33,482	7,960	...	...	2,26,132
Unirrigated, ...	5,363	1,123	5,341	9,048	11,867	222	22	32,986
Total, ...	1,06,159	3,982	86,376	42,530	19,827	222	22	2,59,118

Adding 30,000 acres on account of Oudh and the 5 permanently settled N.-W. Provinces Districts, the total Provincial indigo area is raised to 2,89,118 acres.

Trade.

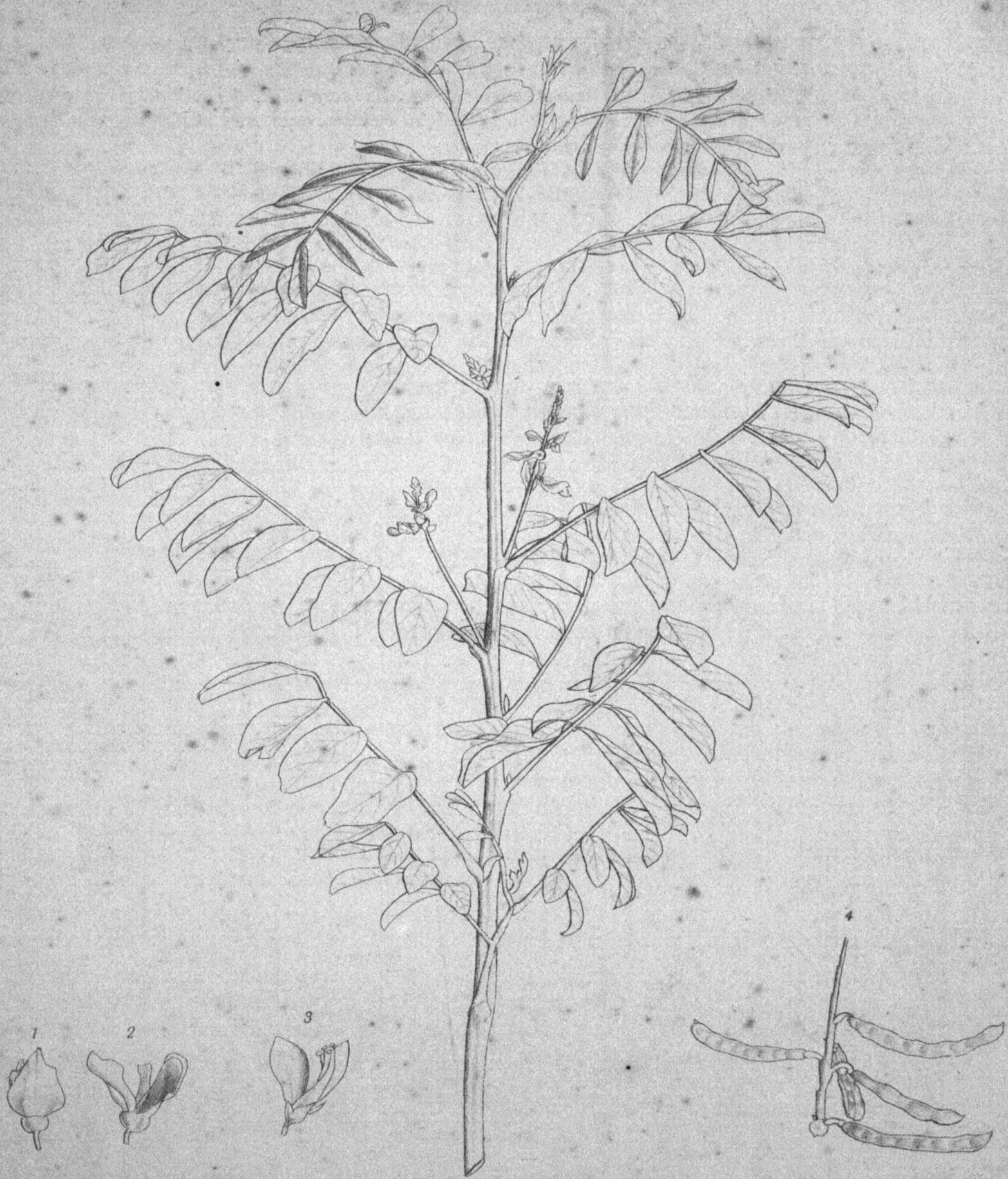
The exports of indigo during the last three years are given in the following table:—

	1878-79.	1879-80.	1880-81.
	mds.*	mds.*	mds.*
To Calcutta, ...	50,157	25,063	40,910
To other places, ...	7,881	3,726	5,062
Total, ...	58,038	28,789	45,972

Explanation of Plate XII.

1. Flower seen from behind,
2 & 3. Side views of ditto, } enlarged.
4. Raceme of pods (nat. size).

* Government maunds of 82 lbs. not factory maunds.



INDIGOFERA TINCTORIA, L.

Drawn by M. Hormusjt

Litho. T. C. Press, Roorkee.
Thos. D Bona, *Supdt.*

CARTHAMUS TINCTORIUS, *Linn.**

[*Vide* Plate XIII.]

ENGLISH, **safflower**; VERNACULAR, **kusum, kusumbh, kar** (the seed), **barre** (in the Benares Division).

Description.

Natural order *Compositæ*, tribe *Cynaroideæ*. A glabrous thistle-like† herb with reddish orange flowers. Stems about 2 ft. high, much branched above. Leaves sessile, oblong lanceolate, with serrate aculeate edges or nearly entire. Flowers in large compact heads; outer involucre bracts leafy, ovate oblong, constricted above the base, entire or spinulose, inner bracts narrower. Florets tubular, hermaphrodite or a few of the marginal ones sterile, tube slender, limb oblong. Anthers sagittate at the base. Achenes ¼ in., smooth, obovoid, truncate at the top, obliquely 4-angular, with four projecting ribs.

Varieties.

The product for which the safflower plant is mainly cultivated is the beautiful pink dye yielded by its flowers, which is familiar in the rose coloured turbans worn by the Marwari traders of Rajputana. But the seed is also of considerable value as an oil producer, yielding a bland clear oil, which is occasionally used to adulterate *ghí*, and forming in its refuse an oil cake which is much appreciated by cattle. The foliage of the plant in ordinary cultivation is thickly armed with spines, but a smooth leaved variety known as *murilia* (or "shaved") is reported to be grown in the Azamgarh District.

Distribution.

Safflower cultivation is almost entirely concentrated in the Meerut Division, which contains 89 per cent. of the total area under it in the 30 temporarily settled N.-W. Provinces Districts. Next to Meerut its cultivation is most extensive in Rohilkhand, which contains, however, only 5 per cent. of the total area, and in no other Division does the area exceed 3 per cent. of the total. The reason for this unequal distribution lies principally in the fact that the demand for the dye is almost solely from Rajputana, and until lately has been met entirely through the market of Dehli, and it is therefore in this neighbourhood that its cultivation has been stimulated. The District which is most closely connected with Dehli is Bulandshahr in the Meerut Division, and this contains 91 per cent. of the area under safflower in this Division, and 81 per cent. of the total area in all the temporarily settled N.-W. Provinces Districts. Without doubt, however, the light soil of the Meerut Division is specially suited to it, and that safflower is considerably affected by local differences is proved by certain particular villages having obtained a name for the peculiar excellence of the dye their soil produces; amongst these may be mentioned Ganeshpur in the Meerut and Sánkni in the Bulandshahr District. Since safflower does not form a separate heading in the annual

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* **References**:—Boiss. Fl. Orient. iii. 709; Clarke Comp. Ind. 244; Hook. Fl. Ind. iii. 386; Roxb. Fl. Ind. iii. 409; Powell Punj. Prod. 355; Drury Useful Pl. of Ind. 116.

† High cultivation reduces its spiny character as in the case of the *bengan* (*Solanum Melongena*) and many other plants which in their wild state are very prickly. Mr. C. B. Clarke believes that *C. oxyacantha*, Bieb., indigenous in the Punjab, may be the wild original of safflower.

crop returns, the available statistics of its area are by no means accurate, since they were only collected as a special measure in a single year (1881-82), and only include that portion of the area which was covered by (*a*), safflower alone; (*b*), safflower and carrots; and (*c*), safflower and cotton, excluding the large area on which it is grown mixed with barley or gram. The returns indicate that the area thus cropped in the 30 temporarily settled N.-W. Provinces Districts extends to between 17,000 and 18,000 acres, only 38 per cent. of which are irrigated.

Mixtures.

The area on which safflower is sown alone constitutes but a very small portion of the total. It is most commonly sown in gram fields,—generally disposed in lines like rape or linseed,—but also very frequently accompanies carrots, and in this combination forms a crop very commonly met with on small plots in the vicinity of wells. It is also occasionally sown in cotton fields in the course of the last weeding they receive, since the cotton harvest is, as a rule, well over before the safflower plants begin to reach maturity.

Soil.

As has been already pointed out, safflower appears to prefer a light soil, although it will grow on almost any land which will bear a crop of gram. If it be grown with carrots it reaps the benefit of a good manuring which they almost invariably receive, but it is rarely given manure on its own account, nor when grown, as most commonly happens, with barley or gram.

Cultivation.

It is sown early in October, preferring a date a little later than that for carrots, and a little earlier than that for gram. It commences flowering in February, and picking continues from then till the end of March, its seeds ripening in April. In the rare instances of its forming a sole crop its seed is sown at the rate of 10 or 12 seers to the acre. When mixed with another crop it is usually disposed in lines, and the amount of seed used in this case varies of course with the caprice of the cultivator. The method of cultivation followed is precisely similar to that of the ordinary rabi crops. Safflower is dependent for its irrigation as for its manure on the character of the crop with which it is associated. If this be carrots it receives as many as four or five waterings, but if barley or gram it is generally left to make shift without any at all.

Harvesting.

The dye for which the plant is cultivated resides in the small orange coloured florets which issue from the teazle-like *capitula* or flower heads. The florets commence appearing in February, and are carefully picked every two or three days, the remuneration for picking being commonly paid in kind at the rate of $\frac{1}{10}$th of the produce. When dry they are as a rule sold to the travelling agents of merchants in the Rajputana or Calcutta trade, the usual price being from 2 to 3 seers per rupee. The subsequent treatment of the florets depends on their being destined for export as the safflower of commerce or for local consumption. In addition to the pink dye to which the florets owe their value, they contain a yellow pigment which must be extracted before they can be used in dyeing. In the case of the safflower of commerce, this extraction is effected by crushing the florets either with a pestle or in kneading them with the feet while a stream of water is allowed to run over them, and pass through a strainer. In this manner the yellow colouring is washed out of the florets, and the process is persevered with until the water runs off clear. The florets are then made up into round flat cakes and, when dried and pressed, are ready for market.

When safflower is intended for dyeing in this country the extraction of the yellow

pigment forms merely a preliminary process in the art of dyeing, and is not held necessary in order to prepare the florets for sale in the market. The method in which the extraction is effected is similar to that described above.

The yellow pigment of safflower is readily soluble in water, but safflower red (or carthamin) needs the presence of an alkali as a solvent. The yellow pigment (or *piyan*) is, as a rule, considered useless, but is occasionally used as a base on which the more valuable red dye is applied. So soon as its extraction has been completed an alkali is mixed with the florets, the ash of the *bájra* (*Penicillaria spicata*) or of the *chirchira* (*Achyranthes aspera*) being used for this purpose where possible, since they contain a large proportion of potash. Impure carbonate of soda (*sajji*) is not uncommonly used in the proportion of half chittack to a seer of florets. The alkali is well mixed with the florets and the mixture rubbed into a paste, which is placed over a cloth strainer and readily yields a deep red pigment to a stream of water poured over it. The safflower is washed three times in this manner, each time with water in the proportion of 2 seers (= 2 quarts nearly) to a seer of florets, and three tinctures of different strength and quantity are obtained. Cloth is dyed by being immersed in the tincture and dried, the depth of the shade depending on the number of times this process is repeated. Carthamin is precipitated by an acid, and acidulated water is often used to fix the colour on the cloth.

The picking of the florets does not prevent a crop of seed, since the embryo seed is not detached with the flower, and is, as a rule, fertilized before the flower is picked. The use of the seed as an oil producer and as food for cattle has been already noticed. In some Districts (*e.g.*, Cawnpore) the seed is made over to the professional oil presser (*télis*) for extraction of the oil. In others (*e.g.*, Azamgarh) the oil is extracted by the cultivator, not by pressure but by a process somewhat resembling distillation. "An "earthen vessel is sunk in the ground and on its mouth another vessel is placed, in the "bottom of which a small hole is pierced. In this upper vessel the seed is placed, and "round the outside of it a fire is kindled. As the seed is gradually roasted the oil "exudes from it and drips into the lower vessel"—(Azamgarh Settlement Report.)

Diseases and injuries.

Lightning is popularly supposed to do great injury if it occurs while the heads are in flower, and the plants are reported to suffer occasionally from the attacks of an insect known as the *ál*, the scientific name and affinities of which have not been ascertained.

Cost of cultivation.

The cost of cultivation of an acre of safflower grown alone may be put at Rs. 15-2, allowing Rs. 13-10* for tillage, sowing, irrigation and rent, and Rs. 1-8 for the cost of picking.

Average outturn.

The average outturn of dry florets per acre of safflower sown thickly amongst carrots may be put at 30 seers worth about Rs. 15, with 5 maunds of seed worth Rs. 5 more. The value of the dry florets would be much higher were it not possible to grow safflower as a subordinate crop, without much damage to the crop with which it is associated. In other words its price is not so much regulated by its cost of production as by the loss which its mixture occasions to a crop of barley, gram or carrots.

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* Assuming that the cultivation is on a par with that of irrigated barley, (*see* page 11.)

Area.

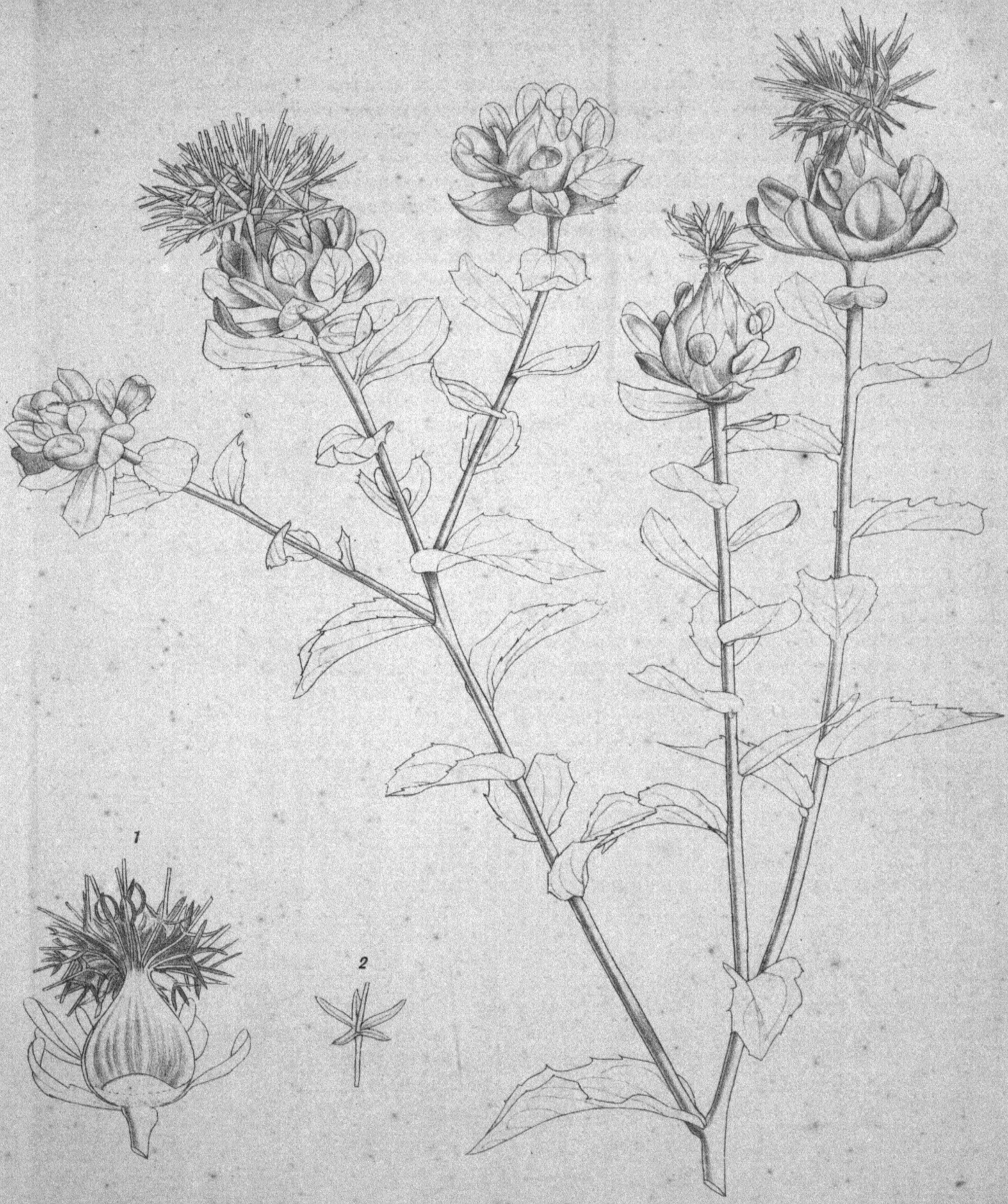
Statistics of the area under safflower are only possessed for the 30 temporarily settled N.-W. Provinces Districts, and these too of a very imperfect character, since they are only for a single year and merely relate to that portion of the area on which safflower was grown which was not included under any of the major heads of the annual crop returns. The figures therefore only serve to indicate the area under (*a*), safflower alone; (*b*), safflower and carrots; and (*c*), safflower and cotton, and do not include the extensive area on which it accompanies gram or barley.

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Gorakhpur and Basti Districts only.	Jhansi Division.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	6,150	38	55	42	269	12	6,566
Unirrigated, ...	9,333	784	116	382	132	9	10,756
Total, ...	15,483	822	171	424	401	21	17,322

Explanation of Plate XIII.

1. Head of flowers, vertical section,
2. Single floret,

} nat. size.



CARTHAMUS TINCTORIUS, L.

Drawn by H. Hormusji.

Litho. T. C. Press, Roorkee.
Thos. D. Bona, *Supdt.*

SACCHARUM OFFICINARUM, *Linn.**

[*Vide* Plate XIV.]

ENGLISH, **sugar-cane**; VERNACULAR, **ikh, ikhari** (in Western Districts), **ukh, ukhari** (in Eastern Districts), **nai shakar** (Persian).

Description.

Natural order *Gramineæ*, tribe *Andropogoneæ*. A large perennial grass. Stems many, 6-12 ft. high, thick, solid, jointed, polished, yellow purple or striped; lower internodes short with fibrous roots above each joint. Leaves very large, crowded, lower ones soon falling off; ligule short, entire; sheaths about one foot in length, striate, smooth or with mealy pubescence; blade 3-4 ft. long and from 1½ to 2 inches in breadth, acute, smooth on both surfaces, margins minutely serrulate, ciliate at the base; midrib prominent beneath. Panicles large, compound, drooping, feathery, of a greyish colour. Spikelets small, very numerous, 1-flowered†, arranged in pairs on alternate sides of the long slender panicle branches, one stalked and the other sessile, each enveloped in an involucre of long white silky hairs; glumes 2, nearly equal, lower 2-nerved and ciliate towards the apex, upper 1-nerved; outer pale wanting, inner shorter than the glumes. Lodicules 2, free, truncate, lobed. Stamens 3; anthers linear, oblong. Ovary smooth; stigmas 2, densely plumose, purple. Fruit not known.

Varieties.

The varieties of sugar-cane are very numerous, and as their names vary greatly in different Districts, it is a matter of some difficulty to identify them. A broad subdivision may be made into edible and non-edible cane, the former being grown for human food in the raw state and eaten as a sweatmeat, while the latter is intended for the production of sugar. Edible cane is, as a rule, much the thicker, softer, and juicier of the two, and is grown with very high cultivation. Its principal variety is the one known as *paunda*, which is supposed to be a recent introduction from the Mauritius. In the Dehra Dún District *paunda* is used for sugar making, but elsewhere it is grown merely as a sweetmeat. The most distinct varieties of non-edible cane are (1), a tall soft cane growing as high as 10 feet, requiring good cultivation and yielding a large proportion of juice (*dikchan* in Rohilkhand, *barokha* in Cawnpore); (2), a shorter and rather harder cane not often more than 5 or 6 feet high, yielding less but richer juice than the above (*agholi, matna*); (3), a hard tall reddish cane of poor quality much grown in damp localities without irrigation (*chin*); (4), a dwarf white hard cane yielding more juice than *chin*, but resembling it in being grown on second-rate land (*dhor*). The two first varieties are delicate and require a rich well manured and well irrigated soil, the two latter yield a crop with much less care and expenditure, and suffer much less from flooding in the rainy season.

Distribution.

The total area under cane in the whole of the N.-W. Provinces and Oudh, may

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* **References.**—Roxb. Fl. Ind. i. 237; Kunth Enum. Pl. V. 384; Bentley and Trimen Med. Pl. 298; Drury Useful Pl. of India 371.

† Many authors describe the spikelets as 2-flowered. Roxburgh (l.c.) says "*Flowers hermaphrodite, in pairs; one sessile, the other pedicelled.*" The question may depend therefore as to whether the pair of 1-flowered spikelets is looked upon as a 2-flowered spikelet, or composed of two 1-flowered spikelets.

be assumed as 9½ lakhs of acres, amounting to 2·5 per cent. on the total cropped area, and 4·8 per cent. on the area under kharif crops. Its cultivation is greatly restricted to certain well marked localities. The natural home, so to speak, of the cane is the strip of damp country underlying the hills which comprises a large portion of Rohilkhand, Oudh and the Benares Division. Here it is often grown without irrigation. But the increased facility for irrigation afforded by canals has led to a great extension of its cultivation in the drier districts of the Ganges-Jumna Doáb, notably in the upper portion of the Meerut Division, where it now forms one of the principal staples. It is also grown very largely in the Districts of the Benares Division which lie between the Gogra and Ganges, where water is near the surface and irrigation from wells and tanks is much practised. South of the Jumna its cultivation is almost unknown, although the occurrence of numerous disused stone sugar-mills in the villages of this tract gives some ground for supposing that it was once one of the local crops. The percentage of sugar-cane to the total cropped area in the temporarily settled Districts of the N.-W. Provinces is shown by Divisions below :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Percentage of area under cane to total cropped area,	3·4	4·4	1·2	·5	3·4	·1	1·6

A striking fact in connection with the extension of sugar cultivation in the Meerut Division is its restriction to the three Northern Districts of Saháranpur, Muzaffarnagar and Meerut, although canal irrigation is equally abundant in the two southern Districts of Bulandshahr and Aligarh. The explanation lies in the large extent of indigo cultivation in these two latter Districts, which has as yet kept the sugar-cane completely in the background.

This is shown below :—

	Saháranpur.	Muzaffarnagar.	Meerut.	Bulandshahr.	Aligarh.
Percentage on total cropped area of—					
Area under cane, ...	3·5	6·4	6·3	1·1	·2
„ „ indigo, ...	·1	·2	·8	4·5	4·4

Seasons.

The sugar-cane season comprises, roughly speaking, a whole year. Sowing commences in February, and the harvesting of the previous year's cane is not concluded till very shortly before this. If, however, cane is to be classified with other crops it must be ranked with those produced in the kharif season, since it is on the warmth of the summer months that its growth principally depends.

Rotation.

A cane crop is, as a rule, preceded by a whole year's fallow, the land not having been occupied in either kharif or rabi preceding. Occasionally, chiefly in the sub-Himalayan tract, it follows a kharif crop of rice or pulse, when it is known as *kharik* as opposed to *pural* or fallowed cane, and its produce is estimated to be decreased by ¼th to ⅓rd. Now and then it is even sown immediately after a crop of gram on land which has not been allowed even a half year's fallow, but this is rare. The rents charged for cane in the Sitapur District are Rs. 10-12, Rs. 9-9, Rs. 8 and Rs. 6-12 per acre according as it is grown after a year's fallow (*purali*), after rice (*dhankeri*), after autumn pulse (*maseri*), or after gram (*charreri*). But these are exceptional cases, and the rule for the Provinces is that cane requires a year's open fallow; land lying fallow for cane is known as *pándra*.

Mixtures.

A crop of melons or onions is occasionally gathered off a cane field, being planted on the ridges of the irrigation beds, and being off the ground before the canes have made much progress. Hemp and castor are frequently grown as a border, but beyond this no subordinate crops are ever mixed with the cane.

Soils and manuring.

Sugar-cane land is usually good loam or light clay, and is invariably manured except in tracts such as the Himalayan Tarai and the old bed of the Ganges in the Etah District, where the ground is saturated with moisture, which is made to supply the place of both manure and irrigation. The weight of manure applied per acre varies between 150 and 200 maunds. In the Sháhjahánpur and Muzaffarnagar Districts it is the custom to apply the whole of the available manure to the cane fields, and the manured fields are therefore not collected in a belt round the village site, as is usually the case, but scattered at intervals over the village land. From Fatehpur the practice of herding cattle at night on cane fields is reported. The manure is applied shortly before sowing and well intermingled with the soil by frequent ploughings.

Tillage.

Ploughing commences with the rains, and is continued in as opportunity offers till sowing time. During November the land is allowed a rest, it being considered unlucky to plough in that month (Bareilly), possibly because it may encourage the germination of weeds, many of which are seeding then. The number of times to which cane land is ploughed is occasionally as many as 25, and averages about 12 or 15.

Sowing.

Cane is propagated by cuttings or layers and not from seed. The cuttings are made either from the upper portion of the cane, which is of but little use for sugar making, or from the whole cane, and must be always long enough to include two internodes, *i.e.*, three nodes or joints. The young canes are produced from buds which spring from the nodes under artificial stimulation, and with an eye to this the seed canes are generally kept for some days buried in damp earth, and sometimes even soaked in water for 12 hours before sowing (Allahabad). The following graphic description of the process and ceremonial of cane sowing is taken from Mr. Moen's Report on the settlement of the Bareilly District:—"An ordinary plough which has been appeased with sacrificial "offerings of turmeric and rice, and decorated with the *tika* (forehead mark) in red "earth strikes the first furrow. This is followed in the same furrow by a second, with "mould board attached to widen and deepen the furrow, behind this comes the sower, "wearing silver ornaments with a necklace of flowers round his neck and a red *tika* on "his forehead. He is usually well fed with ghí and sweetmeats before commencing.

"He is called the 'elephant' (*hathi*). He throws the bits of cane into the furrow "immediately behind the second plough at intervals of about a foot. Behind the "'elephant' comes a second man, called the 'crow' (*kawa*), to pick up the bits which "have not fallen into the furrow, and to put them in properly. There is occasionally "a third man, called the 'donkey' (*gadha*) who accompanies the 'elephant' with a "basket of cuttings and supplies them as they are wanted. It is considered a very "favorable omen if a man on horseback comes into the field when the sowing is going "on. After the sowing is completed all who have been engaged in the work repair "to the house of the cultivator of the field and are treated to a good meal." The assistance or at least encouragement of half the village is a common result of this latter custom.

The cuttings are covered with earth by a third plough following the sower, and, since the rows should be at least a foot apart, it is usual to strike two or three blank furrows between the one in which the seed has fallen and the one next sown. The amount of seed used per acre is about 20,000 cuttings, which represent some 3,000 to 5,000 canes.

Cane is occasionally ratooned, *i.e.*, allowed to spring up from the roots of a previous crop, in which case the juice is said to be richer than in the first year, but only $\frac{1}{2}$ to $\frac{2}{3}$rds as much in quantity.

Irrigation.

On a comparatively small area cane can, as has already been noticed, be grown without irrigation at all, and over a great portion of Rohilkhand the ground often contains sufficient natural moisture in February to enable sowing to take place without a previous watering. But as a general rule this previous watering is required, and between sowing time and the commencement of the rains waterings are necessary, which vary in number from three or four in the Meerut Division, to eight in the drier Districts of the lower Doáb. Occasionally a watering is given in October or November if the rains have ceased early. It may be mentioned that *khari* water, *i.e.*, water impregnated with nitrates, is harmful to cane, seriously affecting the quality of the juice. In the few localities where cane is grown in Bundelkhand, a practice (called *palwár*) prevails of economizing water by covering the ground to a depth of 6 inches with grass and leaves, so as to prevent the rapid evaporation of moisture.

Weeding.

Two weedings are generally given, but they play an unimportant part compared with the frequent hoeings which are an essential feature in cane cultivation. The hoeing is performed with a small pickaxe, the earth between the rows of canes being thoroughly stirred to the depth of 6 or 9 inches. The first hoeing should take place when the young shoots appear above ground, and from that time to the commencement of the rains it should be hoed at least three times. When the rains have once set in the crop may be left to shift for itself, and will effectually stifle any weeds which may attempt to compete with it.

Harvesting.

Cane cutting nominally commences with the Deothan festival, which falls on a date varying in the solar calendar, but generally about the beginning of November. But practically it is generally delayed till a month later, and the cultivator has completely finished his rabi sowings. The delay is an advantage in one respect, since the juice of canes cut early in the season, though more abundant, is much less rich in crystallizable

sugar than that of canes cut in January and February, and it is probable that it is due more to the slowness of the sugar crushing process than to any other consideration that cane cutting commences so early as it does. The instrument used for cane crushing is known as the *kolhu*, and consists essentially of a large wooden or stone mortar in which a huge wooden pestle is made to revolve by the traction of a pair of bullocks. The pestle is in a slanting position so as to roll round the sides of the mortar as it is turned, and it is kept in its place by being connected by a long upright with one end of a flat horizontal beam, the other end of which abuts upon and slides round the base of the mortar. The cane is cut up into short strips, which are placed in the mortar and are crushed by the pestle as it rolls over them, the juice running down into an earthen jar. Working night and day a *kolhu* will not press more than 1½ acres of cane in a month, and it is dangerous as well as inefficient, since a sudden breakage of the pestle often results in the injury, if not death, of the bullock driver below, and the fingers of the man who fills in the cane are often crushed beneath the pestle. A portable iron roller mill (patented by some English Zemindárs in Behar) is rapidly attaining such popularity as to encourage the belief that in a few years it will altogether supplant the *kolhu* in some parts of the Provinces. It can be worked by a single bullock, and saves the labour of at least one man, since the canes have not to be cut up into pieces but are pressed whole. When to this it is added that the juice which it delivers is far purer and cleaner and yields sugar worth almost 25 per cent. more than that made from juice expressed by the *kolhu*, it is no matter for surprise that within the last few years over 15,000 have been sold in these Provinces and Behar, and that the supply is not equal to the demand.

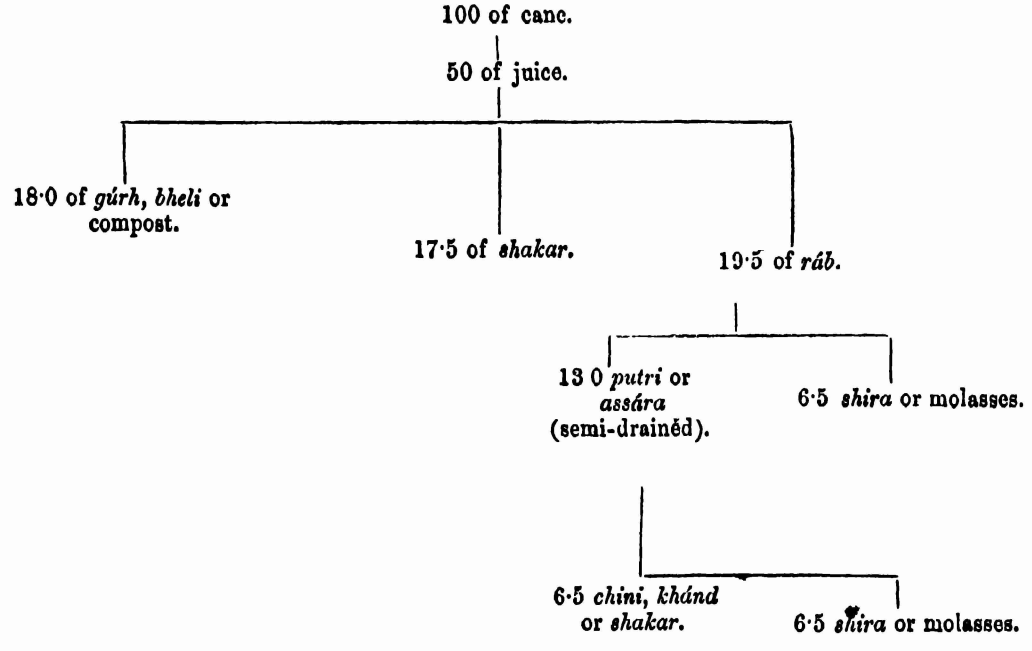
The boiling of the juice follows on the pressing with as little delay as possible, since fermentation rapidly sets in from exposure to the air. The process of boiling and concentration varies according as its result is to be *gúrh*, *shakar* or *ráb*. *Gúrh* is a compost of sugar crystals and uncrystallized syrup boiled till of a sufficient consistency to be made up into soft balls or cakes (*bheli* or *chakki*). *Shakar* is formed when the boiling is a little more prolonged and the mixture of crystals and syrup is violently stirred while cooling, when its colour becomes lighter and it crumbles into small pieces. In *ráb* making the boiling is not so prolonged, and the result is syrup containing masses of crystallized sugar embedded in it. *Gúrh* and *shakar* are for human consumption as they are, but *ráb* only represents the first stage in the manufacture of crystallized sugar. With *gúrh* and *shakar* the object is more to obtain a good colour than good crystallization, while the value of *ráb* entirely depends on the proportion of crystals which it contains. Hence the boiling process for *gúrh* and *shakar* is, as a rule, much rougher than when *ráb* is manufactured.

The boiling apparatus consists of a furnace excavated in the ground, over which one or more iron pans are set. If the boiler is supplied from only a single *kolhu*, as a rule one pan is used, while if two or more *kolhus* are used the number of pans is often increased to four or five, which are of different sizes and are placed in order, the largest one furthest from the feed end of the furnace, and the smallest one immediately over it. In this form the boiling apparatus is very similar to that formerly used in the West Indies. The use of a row of pans on this principle effects a great saving of time, and also perhaps enables the manufacture of better sugar, though this is by no means proved.

The juice is collected in the large pan where it is allowed to simmer slowly; scum rises to the surface; the formation of which is sometimes assisted by the addition of alkali (carbonate of soda) which promotes the coagulation of albuminous matter, or of milk, or the sticky juice of the edible Hibiscus, which in becoming coagulated collect and bring to the surface a good deal of impurity. From the large pan the juice is baled into the one next it, and so on from pan to pan down the series, becoming more concentrated in each transfer until it is finally worked up into sugar in the last and hottest pan.

The preparation of sugar from *ráb* is not properly speaking an agricultural process, and needs therefore no notice in this account. It may be briefly mentioned that the process substantially consists in draining the uncrystallized molasses away from the sugar crystals. This is effected in the Western Districts by pouring the *ráb* into cloth bags and subjecting it to pressure, in which way about half of the molasses are strained off, and then placing the semi-pure result (called *putri* in the Western, and *assára* or *assára* in the Eastern Districts) in wicker crates, and allowing the molasses to filter slowly down, this filtration being assisted by a covering of the water weed known as *siwár* (*Hydrilla verticillata*), the moisture from which slowly filters downwards and washes the crystals clean. The European process of "claying" was on exactly the same principle. The flowry whitish sugar which results is known as *kacha chini* or *khánd*, and is made over to the *halwáis* for final refining.

The following diagram shows the average outturn per cent. of cane of each of the products mentioned above:—



Of the sugar exported from the Meerut Division, 98 per cent. is in the form of *gúrh* or *shakar*, but only 44 per cent. of that exported from Rohilkhand, the balance (56 per cent.) consisting in *chini* or *khánd*, the product of *ráb*. This difference illustrates something more important than a dissimilarity in local custom or even in quality of cane, for it represents a material difference in the distribution of the profits of sugar cultivation

between cultivator, landlord and capitalist. When a cultivator manufactures his own sugar he nearly always makes *gúrh* or *shakar*, and *ráb* is, as a rule, only made by professional sugar-boilers or *khansáris*, with juice which they purchase from the cultivators. These purchases are all negotiated, like those of indigo factories and the Opium Department, by means of advances, and the system has so important a bearing on the agricultural condition of a large portion of the Provinces, that it may not be out of place to quote here some remarks on its working, written by Mr. Moens when Settlement officer of the Bareilly District :—

"The bargains for juice commence in May, and are usually all concluded by September. The price per "100 kacha maunds of juice is agreed on between the parties, and the amount of advances per bigah "to be made by the merchant or *khansári*. A bond is then executed by the cultivator, specifying the price "per 100 kacha maunds of juice, the amount of advance, and the rate of interest; which is usually 1 per "cent. per month; occasionally, however, Rs. 2 and even Rs. 2-8 per month is charged. The field of cane "is hypothecated as security for the advance, and there is a condition usually added by which the cultivator "binds himself to repay 1½ times the amount of advance, if he sells the juice to any other party, or works "it up himself into *gúrh*. As soon as the bond is executed the cultivator receives Rs. 5 per bigah down in "cash, and a promissory note for the remainder, to be paid when his November, December and February "instalments of rent fall due. As soon as the sugar boiling is over the accounts between the *khansári* and "cultivator are made up, the latter being credited with the amount of juice received at the price specified in "the bond. If, as is usually the case, a balance remains against the cultivator, he is charged interest at 1 "per cent. per month on the balance from the date of the execution of the bond, and the total sum due is "deducted from its advances in the next year. Though convenient in one way to the cultivator, as giving "him the command of a few rupees just when he wants them to pay his rent, yet the system is ruinous to "him in the long run. Once in debt he can hardly ever extricate himself, for then the price of the juice in "future is always fixed by the *khansári* below the market price, and the rate of interest is raised. The cul- "tivator must consent or be sued in the Civil Courts for the balances due, sold up, and ruined. I have known "as low a price as Rs. 16 per 100 kacha maunds entered in the bonds, when the ruling price in the open "market was Rs. 26 and 27. I have known in the same year, at the same time, and in the same village, one "cultivator get only Rs. 21, and another Rs. 28 for the 100 kacha maunds. The system is profitable to the "zemindár, who has a good security for his rent, for he will not allow the cane to be cut until his demands "are satisfied, and the *khansári* must see that the rent is paid or he will be a heavy loser. Besides this the "zemindár often acts as the distributor of the advances, taking so much per cent. from the *khansári* and the "cultivators. In the long run therefore, the extension of the advance system can not be considered to have "been productive of any real benefit to the district, as it has tended to render the cultivator less independent "and to have increased his indebtedness."

In the sugar districts of the Meerut Division on the other hand the rule is for the cultivator to boil his own cane juice, and add the profits of manufacture to those of cultivation. It is generally assumed that the cultivating classes of these districts are the most prosperous in the Provinces, though their prosperity may be perhaps bought by a loss in the total value of the produce.

Diseases and injuries.

The most serious injury to cane grown on low lands results from being flooded in the rainy season, and large areas of cane may often be seen during the cold weather reduced to a mere snipe cover by the overflow of the tank or river on whose banks they are situated. Cane also suffers at times from the attacks of caterpillars, one kind called *kanswa* in the Meerut District, attacking the young shoots, and another known as *silái*, the full grown plants. Jackals are also fond of sugar-cane, and do a great deal of injury, especially to the softer varieties, unless the fields are watched at night.

Cost.

The average cost of growing an acre of cane is shown below:—

	Rs.	A.	P.
Ploughing (twelve times), ...	9	0	0
Clod crushing (six times), ...	0	12	0
Seed (4000 canes), ...	8	14	0
Sowing (three ploughings and three men), ...	1	14	0
Weeding (twice), ...	4	0	0
Hoeing (three times), ...	5	8	0
Watching, ...	2	0	0
Cutting, ...	2	8	0
Total, ...	34	8	0
Manure (200 maunds), ...	6	0	0
Irrigation (seven times), ...	12	5	0
Rent, ...	10	0	0
Grand Total, ...	62	13	0

The average cost of making a maund of *gúrh* has been proved to be Rs. 1-6, so that assuming an outturn of 30 maunds, the manufacturing expenses will amount to Rs. 41-4. Adding this to the cost of cultivation we obtain Rs. 104-1-0 as the cost of producing 30 maunds of *gúrh*.

Outturn.

The average outturn of irrigated cane calculated in semi-dried compost (or *gúrh*) may be taken as 30 maunds per acre in the Meerut, Rohilkhand, Lucknow, Rai Bareli and Benares Divisions, 24 maunds per acre in the Sitapur and Fyzabad Divisions, and 20 maunds per acre in the Agra and Allahabad Divisions. For the small amount of cane grown in Bundelkhand, an outturn of 18 maunds an acre would be a high average. If *ráb* is made instead of *gúrh*, the outturn will be about 8 per cent. more than this, and if *shakar* be made about 3 per cent. less.

Area.

The average area under sugar-cane in the 30 temporarily N.-W. Provinces Districts is shown below by Divisions, being calculated on the returns for 1878-79, 1879-80 and 1880-81 :—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	1,50,531	94,280	41,260	23,590	1,18,744	1,407	853	4,30,665
Unirrigated, ...	24,103	1,06,157	12,144	1,061	32,888	44	2,189	1,78,586
Total, ..	1,74,634	2,00,437	53,404	24,651	1,51,632	1,451	3,042	6,09,251

The area in Oudh and the 5 permanently settled N.-W. Provinces Districts is returned as about 3½ lakhs of acres, bringing up the total Provincial area to between 9 and 10 lakhs of acres.

Trade.

The net exports of sugar by rail during the last three years are shown below :—

Drawn by H. Hormusji

SACCHARUM OFFICINARUM, LINN.

Litho. T. C. Press, Roorkee.
Thos. D. Bona, Supdt.

Net export.	Maunds.			Rupees.		
	1878-79.	1879-80.	1880-81.	1878-79.	1879-80.	1880-81.
Drained, (*chini* and *khánd*,) ...	1,78,058	1,72,363	(net imp.) 13,933	32,05,044	24,52,184	(net imp.) 1,38,574
Undrained, (*gúrh* and *shakar*,)	7,53,080	19,14,840	(net exp.) 23,02,945	52,71,560	1,22,80,012	(net exp.) 1,59,47,951
Total, ...	9,31,138	20,87,203	22,89,012	84,76,604	1,47,32,196	1,58,09,377

Explanation of Plate XIV.

1. Entire plant (⅛ nat. size).
2. Leafy offset (reduced).
3. Piece of matured stem,
4. Rhizome,
5. Branch of inflorescence,

} nat. size.

6. A pair of spikelets,
7. A stalked spikelet,

} enlarged.

8. The pale,
9. Lower glume,
10. Upper glume,
11. A Flower,

} much enlarged.

Figures 5-11 copied from Plate 298 of Bentley and Trimen's "Medicinal Plants."

PAPAVER SOMNIFERUM, *Linn.**

[*Vide* Plate XV.]

ENGLISH, **poppy,** (product opium) ; VERNACULAR, **posta,** (product *afím*.)

Description.

Natural order *Papaveraceæ*, tribe *Papavereæ*. An annual herb with a much-branching yellow root. Stems branched, 2-4 ft., erect, cylindrical, solid, smooth or with a few bristly hairs, pale green, covered over, as also the leaves, with a whitish bloom which is easily rubbed off. Leaves close together, alternate, sessile, shining, smooth or with a few scattered bristles underneath ; lower ones about 6 in. long, oval-oblong, deeply lobed, and with the lobes coarsely dentate ; upper ones 8-10 in. in length, ovate-oblong, cordate, amplexicaul, less deeply lobed but with larger teeth, the teeth with hard white points, dark green above, paler on the underside ; midrib and veins prominent. Flowers large, solitary, erect, on long peduncles ; buds ovoid, drooping. Sepals 2, broad, leaflike, falling off as the flower expands. Petals 4, large, fugaceous, the two outer ones much broader and overlapping the other two, pure white (in the cultivated plant) or tinged with violet and with a purple basal spot. Stamens numerous, inserted in several rows beneath the stalk of the ovary ; filaments flat, white ; anthers attached by their base, pale yellow. Ovary nearly globular, supported on a distinct stalk (gynophore), smooth, 1-celled, with numerous narrow placentæ projecting from the walls almost to the centre ; ovules very numerous, scattered all over the placentæ ; stigma sessile, peltate, with many oblong obtuse rays spreading over the top of the ovary. Fruit nearly globular, or depressed at each end, 1-3 in. in diameter, dry and brittle, yellowish brown with black specks, dehiscing by small openings under the stigma ; placentæ dry and papery, reaching about half way to the centre. Seeds many, small, reniform, white or black, sharply reticulate ; embryo curved.

Varieties.

Native cultivators distinguish several varieties of poppy, there being as many as four grown in the Azamgarh District, differing but little in outward appearance, but considerably in the amount and quality of the opium they produce. The varieties grown in these Provinces are all of the white flowered kind, which is found better suited to the climate than the red or purple flowered kind extensively grown in Malwa. Apart from their colour the flowers of the red or purple poppy may be readily distinguished from those of the white poppy by having the margin of their petals fringed instead of evenly rounded. Occasionally red flowers may be seen in a poppy field of these Provinces, but they are as a rule eliminated as soon as they appear,—some say because they are apt to prejudice the crop by attracting the evil eye, and others because their produce is inferior to that of the white flowers, and they should therefore be allowed no opportunity of hybridizing with them.

Distribution.

Except in the hills of Jaunsár to the north of Dehra, the cultivation of the poppy is strictly prohibited unless on account of Government. In Jaunsár fields of poppy are to be met with up to 5,000 feet, the produce of which is wholly consumed locally or in the adjoining hill tracts under native rule. In the plains poppy cultivation has been restricted by Government to certain well defined tracts in order to render its supervision

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* **References** :—Hook. Fl. Ind. i. 117 ; Bentley and Trimen Med. Pl. 18 ; Roxb. Fl. Ind. ii. 571 ; W. & A. Prod. 17 ; Voigt Hort. Suburb. Calc. 5 ; Powell Puni. Prod. 293 ; Drury Useful Pl. 327.

easier, and hence its distribution is artificial, and is only partially dependent on natural qualifications of soil and climate. In the Meerut Division no poppy is grown down to Aligarh, the easternmost District, in which its cultivation commences. Some years ago its introduction was attempted in Saháranpur (and Umballa), but was subsequently abandoned. It is grown in all the Districts of Rohilkhand, but in insignificant quantities, except in Budaun and Sháhjahánpur, in which the area under it amounts respectively to some 8,000 and 10,000 acres. Every District in the Agra Division also returns some opium cultivation, which is of very small proportions in the case of Muttra and Agra, but extensive in Farukhabad (21,000 acres), Etáwah (13,000 acres), and Mainpuri (10,000 acres). In the Jhansi Division opium cultivation is limited to the Jalaun District, but it is permitted in all the Districts of the Allahabad and Benares Divisions. The area is exceptionally large in Oudh and the Districts of the Benares Division, and the total Provincial area under opium amounts in ordinary years to at least 2½ lakhs of acres, or to ·6 per cent. on the total cropped area, and 1·3 per cent. on that portion of it under rabi crops.

The system on which opium is grown for Government is not unlike that on which *badni* indigo is grown for an indigo factory. Every cultivator wishing to grow the plant must obtain a written license to do so, and receives at the same time an advance in cash of from Rs. 12 to Rs. 13 an acre, paid in two instalments, one, two months before the poppy is sown, and the second, one month after sowing. The whole of the produce is purchased by Government, at a rate varying between Rs. 4-8 and Rs. 6 a seer. Under these conditions one would have imagined that poppy cultivation would be extremely popular with the people, but it is tolerably certain that this is not the case, and that it is in many cases only the urgent need of cash to pay their kharif rent (in which the first instalment of opium advance is generally expended) that induces many men to undertake poppy cultivation at all. In some tracts its introduction has been resisted with extraordinary persistency. More than fifty years have passed since attempts were first made to extend its cultivation to the portion of the Allahabad District which lies north of the Ganges. The Settlement officer writes that—"the people then assembled, "rooted up the obnoxious plant, and threatened excommunication to any member of the "tribe who should again attempt its culture. They are of the same mind still (1876). "I have often enquired the reason of this, but all the answer I can get is the 'panchayet "'has interdicted it.' Why this was done in the first instance, except from a spirit of "opposition to the powers that be, I can not imagine, and the cultivators either cannot "or will not tell." The Deputy Commissioner of Partabgarh, an adjoining District of Oudh, writes—"Notwithstanding an increase in the area under poppy (from 181 acres "in 1860-61 to 1,289 acres in 1870-71), I am by no means prepared to say that the cul-"tivation is particularly popular." This is all the more inexplicable, since to an outsider the terms on which opium is grown appear to offer many advantages. They afford a loan without interest, a certain market for the produce at a fairly remunerative price, and the opportunity of embezzling a small portion of the produce, which can be disposed of at a large profit, since the Opium officials are entirely dependent on tables of average produce in determining whether the whole produce is surrendered or not, and can exercise no really effective check. The Káchi was formerly the opium cultivator *par excellence*,

and owes his very name to the process of scraping the juice off the capsules (*káchna*), which is one of the most distinctive features in opium growing. The cultivation has now, however, extended to Kurmis and Lodhas in equal proportion with the Káchis, and is gradually spreading to the higher castes, even Thákurs and Brahmins occasionally taking to it.

Seasons. In the hills of Jaunsár the opium season is from February to June, but in the plains it is from October to March, and the poppy may therefore be classed as a rabi crop. If grown on very highly manured land, it often follows a crop of maize or millet in the preceding kharif, which by exhausting some of the richness of the soil prevents all risk of the poppy running unduly to stalk and leaf. It is most commonly grown alone, but occasionally lines of spinach, cress, or safflower are sown amongst it, which are reported to be of service in attracting the attacks of insects which might otherwise injure the poppy plants.

Soils and manuring. A strong loam is preferred, and the field invariably lies in the highly manured circle round the village, known as *goind* or *gauháni*, receiving from 150 to 200 maunds of cattle dung to the acre each year. In Fatehpur the land is often manured by herding sheep or goats on it, the dung of which is supposed to be of peculiar value. The plants benefit greatly if they are irrigated from a well the water of which is impregnated with nitrates (*khári*), and as in the case of tobacco, the selection of a field for opium cultivation is greatly dependent on the accessibility of any well of this description. Earth impregnated with saltpetre (*nona milti*) is also extensively used, chiefly as a top dressing after the plants have come up (Mainpuri), in which manner too well rotted cowdung and ashes are often applied.

Tillage. A finely powdered tilth is absolutely essential, and opium land is ploughed as many times as the cultivator has leisure for.

Sowing. The seed is sown in October, broad-cast, at the rate of about 3 lbs. to the acre, having been mixed with earth to assist in its even distribution, and the log clod crusher is then run over the ground.

Irrigation. The ground is almost always prepared for sowing by a watering, and in the drier portions of the Provinces the plants are irrigated once in every fortnight or three weeks between germination and harvest time. In the Benares Division four or five waterings are generally sufficient.

If the crop can be irrigated with water containing nitrates so much the better, but it is above all things important that the waterings should be timed exactly to the requirements of the plants, and opium cultivators in consequence are shy of the canal. The field is kept scrupulously free from weeds, at least three weedings being as a rule given.

Harvesting. The plants make but slow progress during December and January, but with the commencement of warm nights in February they make very rapid growth, and are in full flower by the end of that month. The harvest commences by collecting the petals as they fall, or in gently detaching them when about to fall, since they are made into cakes (by being pressed together over the warmth of a fire), which the Opium Department purchases for packing purposes. When the capsules are full swelled, opium collection commences by making small scratches or incisions in the rind through which the opium exudes. For this purpose an instrument is used called a *cheni* or *naharni*, which is practically a four toothed comb. It is often made of four small lancets bound to-

gether, and kept apart only by the thickness of the binding string (Azamgarh). The capsule is held in one hand while the comb is drawn down it from its head to the stalk, making four deep scratches. This is always done in the evening, and next morning a gummy juice is found to have exuded from the cuts, which is carefully scraped off with a little iron scoop, a shell, or a bit of bamboo, and placed in an earthenware vessel. This is the crude opium. Each capsule is lanced from three to eight times at intervals of two or three days, and at the end of the season is in this way decorated with parallel scores round its whole circumference. Only a certain portion of the crop is lanced each afternoon, so that the whole field takes two or three days to pass under the operation, at the end of which a fresh start is made from the first lanced plot; in this way continuous work is afforded to the cultivator and his family. When the juice has all been extracted the capsules are cut off, the seed which they contain selling for oil manufacture at a rather less price than rape commands at the time. The empty capsules are purchased by native druggists (*pansáris*), since they are an exceedingly efficacious material for poultices and fomentations.

Diseases and injuries.

Caterpillars occasionally do some damage, and it is with a view to attracting them elsewhere that such crops as lettuce are sometimes mixed with the poppy. An east wind during lancing time is exceedingly harmful, since the juice will not then exude properly, and this is the origin of the complaints most frequently heard from opium growers.

Cost of cultivation.

The cost of cultivating an acre of poppy is given below:—

	Rs.	As.	P.
Ploughing (eight times), ...	6	0	0
Clod crushing, ...	0	4	0
Seed, ...	0	2	0
Sowing, ...	0	3	0
Making water beds, ...	0	3	0
Watering (six times), ...	9	8	0
Weeding (four times), ...	3	0	0
Harvesting (8 coolies at 2 annas a day for 15 days), ...	15	0	0
*Manure (200 maunds; ⅓rds of cost), ...	4	0	0
	38	4	0
*Rent (⅓rds of annual), ...	10	0	0
Total, ...	48	4	0

Average outturn per acre.

The records of the Ghazipur Opium factory indicate that the receipts of standard opium from cultivators in the Azamgarh District averaged on 16 years, 9 seers per acre. That a certain amount of opium is, however, illegally retained by the cultivators, appears to follow from the startling difference in the consumption of Government opium in Districts where the poppy is and is not cultivated. During the year 1879-80, for instance, the sales of Government opium in the Moradabad District amounted to 2,369 seers, whereas in the adjoining District of Budaun they amounted to only 387 seers. The key to the difference is found in the fact that the area under opium in Budaun was 7,944 acres, while in Moradabad it was only 19. Taking consumption as proportional to population, Budaun to be on a par with Moradabad should have taken 1,858

* Only ⅓rds of the cost of manure and of the annual rent are charged, since at least ⅓rd of each must be debited to the crop of maize which nearly always precedes opium in the Kharif.

seers, and the differences between this and 387, that is to say 1,471 seers, or about ·8 of a seer per acre, may be taken as the least possible amount of opium retained by cultivators, making no allowance for any which may have been conveyed beyond the limits of the District, and very possibly lowered the consumption of Government opium in Moradabad as well.

Ten seers of opium to the acre may, therefore, be accepted as the average outturn of crude opium for the Provinces. It may be mentioned that the outturn of *manufactured opium* from the Ghazipur factory in 1878-79 falls at the rate of a little over 7 seers per acre under opium cultivation in that year, calculated as below:—

Area returned for 30 N.-W. Provinces temporarily settled Districts in the fasli year 1286 (1878-79), ...	1,49,998
Oudh area (from Administration Report), ...	*80,371
Estimate for the 5 N.-W. Provinces permanently settled Districts, ...	30,000

Outturn from Ghazipur factory 45,995 maunds = 18,39,800 seers.

$$\frac{18,39,800}{2,60,369} = 7 \text{ seers per acre.}$$

In addition to the opium about 5 or 6 maunds seed will be obtained to the acre, and about 20 seers petal cakes, which are purchased by Government at from 4 to 8 seers per rupee.

Area.

The average area under opium during the last three years in the 30 temporarily settled Districts of the N.-W. Provinces is shown by Divisions below:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	193	18,547	50,730	20,219	48,833	1,193	...	1,39,715
Unirrigated, ...	100	1,014	454	1,373	6,589	...	...	9,530
Total, ...	293	19,561	51,184	21,592	55,422	1,193	...	1,49,245

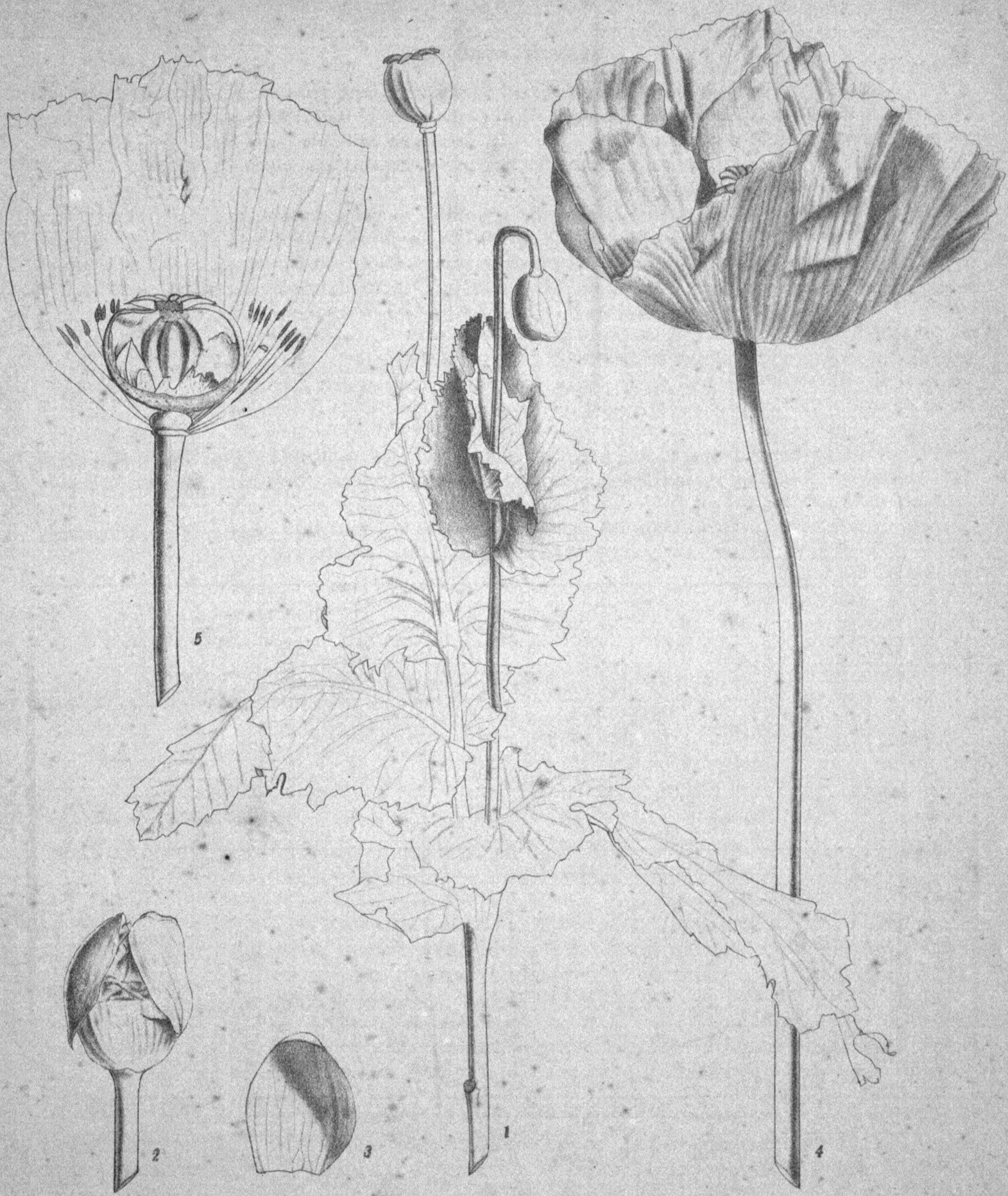
Adding 1,00,000 acres on account of Oudh and the permanently-settled N.-W. Provinces Districts, the total average area is brought up to nearly 2½ lakhs of acres.

Explanation of Plate XV.

1. Upper part of plant bearing a bud and a young capsule, (reduced.)
2. Flower bud, (nat. size.)
3. Single sepal.
4. A flower.
5. Vertical section of ditto.

} nat. size.

* Area under opium was above the average.



PAPAVER SOMNIFERUM, L.

Drawn by H. Hormusji.

Lieke T. C. Press, Roorkee.
Thos. D. Bona, Supdt.

NICOTIANA TABACUM, *Linn.**

[*Vide* Plate XVI.]

ENGLISH, **tobacco**; VERNACULAR, **desi, tambaku, surthi** (when dried for chewing).

Description.

Natural order *Solanaceæ*, tribe *Cestrineæ*. A large rather coarse viscid annual. Stem erect, 4-6 ft. high, not branching, round, solid. Leaves numerous, alternate, the lower ones large, occasionally attaining the length of 2 ft., stalked, oblong or ovate-lanceolate, acuminate, upper ones smaller, amplexicaul, obovate or fiddle-shaped, acute, entire, wavy, bright green but paler on the under side; mid-rib and veins prominent beneath and whitish. Flowers in terminal rounded or oval panicles, shortly stalked; bracts linear. Calyx $\frac{3}{4}$ in. long, tubular, campanulate; teeth 5, unequal, lanceolate, acuminate, about half the length of the tube. Corolla about 2 in. in length, curved, constricted near the middle, pale greenish-yellow, glandular hairy outside, smooth within; limb, 5-lobed, salver-shaped, lobes induplicate in bud, acuminate, rosy-red. Stamens 5, nearly equal, four of them reaching to the top of the corolla-tube and attached to it for $\frac{1}{3}$rd their length, the fifth shorter; anthers deeply 2-lobed, cells distinct. Ovary 2-celled, smooth, conical; style slender equalling the stamens; stigma 2-lobed. Capsule ovate, a little longer than the calyx; placentas axile, thick and spongy. Seeds numerous, very small, of irregular shape, pale brown; testa reticulate.

NICOTIANA RUSTICA, *Linn.*†

[*Vide* Plate XVII.]

VERNACULAR, **calcuttia, tambaku, surthi** (when dried for chewing).

A very different looking plant from the preceding. The following brief description shows its chief distinctive charaeters.

Whole plant viscid-pubescent. Stems 2-4 ft., branching from near the base. Leaves stalked, thick, very prominently veined; lower ones large, on petioles 2-3 in. long, broadly ovate or sub-orbicular, obtuse, sub-cordate, entire, somewhat puckered, glossy; upper smaller and narrower, rounded at the base and shortly stalked. Calyx broadly campanulate; segments triangular ovate, $\frac{1}{4}$-$\frac{1}{3}$ the tube. Corolla about $\frac{5}{8}$ in., broad, cylindrical, constricted near the base, greenish-yellow, viscid-hairy; segments broad, obtuse or bluntly mucronate. Stamens included, attached to the constricted part of the corolla-tube. Style a little longer than the stamens. Capsule globose. Seeds oblong, a little larger than those of *N. Tabacum*.

Varieties.

The tobacco plant is believed to have not been introduced into India until the 17th century, although its cultivation to a greater or less extent is now found in almost every part of the country. In all probability it reached India from Syria, Persia, or

* **References**:—Bentley and Trimen Med. Pl. 191; Powell Punj. Prod. 364; Drury Useful Pl. 311; Voigt Hortus Suburb. Calc. 516.

† (*N. rustica, L.*) DC. Prod. xiii. 563; Geogr. Botanique 849.

Arabia, for the species most commonly grown (*N. Tabacum*) is identical with that from which the tobacco known as "Latakia" is derived; whilst another species of it, separately figured (*N. rustica*), is almost exactly similar to that which yields the tobacco of such widely distant localities as Turkey and the Philippine Islands (Manilla). The flowers of *Calcuttia* tobacco are much shorter in the tube than those of the *desi* varieties, and of a pale yellow instead of a pinkish colour, and its leaves are rounded instead of pointed, stalked instead of sessile, and are further distinguished by a somewhat crumpled appearance. Numerous varieties are now cultivated in these Provinces, some of which are so well marked as to afford foundation for the belief that they owe their origin more to importation of seed from the outside than to mere development in the hands of Indian cultivators.

Distribution.

The dryness of the soil and climate of these Provinces renders them unsuitable for the production of good tobacco, and the area under tobacco would be much smaller than it is were it not for the common occurrence of wells, the water of which is impregnated with nitrates (known as *khári*), and which is therefore especially suited for the production of the coarse pungent weed appreciated by the natives of the country. Possibly too on account of its comparatively late introduction none of the higher castes of cultivators will grow it, and its cultivation is almost entirely restricted to the market gardener caste, known as the káchi, murao, or sáni. Tobacco cultivation may, therefore, be held to follow the distribution of káchis and of khári wells, and it is in consequence restricted within what would otherwise be considered very capricious limits. The total area under tobacco in the N.-W. Provinces and Oudh may be put at 90,500 acres, nearly two-thirds of which are concentrated in the Province of Oudh. In the 30 temporarily settled N.-W. Provinces Districts the area under tobacco amounts to only 0·1 per cent. on the total cropped area, and to 0·2 per cent. on that portion of it under rabi crops. In certain parts of the Provinces it reaches, however, a much higher figure as is shown below:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Percentage of area under tobacco to total rabi cropped area, ...	·50	·16	·41	·19	·04	·04	·04

Seasons.

The months for sowing and cutting tobacco vary considerably in different parts of the Provinces, but the seasons may be conveniently grouped into two. In one case the seed is sown in July and August, the seedlings planted out in October, and cut in February, while in the other case the seed is sown in November, seedlings planted out in February, and cut in April–May. Tobacco grown in the former season is known as *sáwani*, and that grown in the latter season as *asárhi*. Occasionally after cutting a sáwani crop in February the roots are allowed to yield a ratoon crop in the following

May, which is, however, always of very inferior quality. No particular rotation is used. The land is always heavily manured, so that the tobacco is occasionally grown after a crop of maize, and the field does not receive a fallow even in the kharif preceding. And in cases where strong manure is available, such as in the environs of large cities, tobacco commonly forms one of three crops which are regularly taken off the land each year, potatoes in the months November to February following after maize, and being succeeded by a crop of asárhi tobacco.

Soils and manuring.

The manure which is given to the land is so heavy as to make the natural character of the soil a secondary consideration. A loam is undoubtedly the most suitable soil, but if there is the inducement of a khári well, shift will be made with any kind of land, and since khári wells chiefly occur near old village sites, tobacco fields are often met with, the natural soil of which would, if uncorrected by manure, be little else than a collection of brick bats. Fields growing tobacco receive at least 200 maunds of the richest manure available to the acre, but since the land generally bears two crops within the year, the tobacco does not appropriate the whole benefit to itself. In some districts (Fatehpur, Allahabad and Jaunpur) it is the practice to manure tobacco land by herding cattle on it at night, and in the Bijnor District almost the whole of the tobacco is grown on clearings along the forest border which are used to herd cattle in during the rains. The cultivators usually live in villages at some distance, but in the cold and hot weather months migrate to the jungles and establish their tobacco fields, returning as soon as they have cut their crop. A peculiarity of the tobacco plant is its desire for organic salts, and it is to the presence of potash salts, becoming white potassic carbonate in the ash, that the mellowness of flavour in good tobacco is principally due. Hence wood ashes, containing potassic carbonate form one of the best manures for tobacco. But in India these salts are almost always supplied in the form of nitrates, which, while encouraging a strong growth, lend a pungency to the flavour which is very distasteful to Europeans, but highly appreciated by the Natives of the country. It is for this reason that khári well water is so eagerly used for tobacco, containing as it does nitrate of soda in solution, and, when it cannot be obtained, *nona mitti*, or earth impregnated with nitrate or potash (saltpetre), is commonly used as manure, being obtained by scraping the efflorescence from off old walls or the sites of former manure heaps. The walls of a village are always made of mud dug from the village tank, and are therefore strongly impregnated with the derivatives of urine.

Tillage.

The soil must be very finely pulverized, and often owes its preparation more to the mattock than to the plough. If the plough is used it is driven through the land at least eight times, the log clod crusher being dragged over the ground between every two or three ploughings, so as to reduce the soil to a condition as nearly resembling powder as possible.

Sowing.

The seed is sown in nurseries, and planted out when about six inches high. Tobacco seed is exceedingly small, and in order to sow it evenly it is generally mixed with wood ashes. A handful of seed sown in a bed measuring 150 square yards will be sufficient to raise plants for an acre. The soil must be thoroughly moist, and the seed is covered by brushing the earth over it by hand or by a twig brush. The soil round the seedlings must be kept always moist, and this when the seed has been sown after

the end of the rains necessitates a light watering every third or fourth day. The seedlings are thinned out from time to time, and when 6 inches high, are transplanted by hand into the field, being placed in lines at a distance of 6 to 8 inches apart. The thin planting practised in America finds no favour in this country. Transplanting is invariably carried out in the afternoon or evening, and the seedlings are often protected by screens from the heat of the sun for the first few days.

Irrigation.

The field is always prepared for reception of the seedlings by a good watering, and in the drier parts of the Provinces must be irrigated at intervals of about a fortnight until the crop is ripe. It is essential that water should be given immediately it is required, and this partly explains the reluctance of cultivators to trust to canal irrigation for their tobacco.

Weedings.

Weeds are never allowed to spring up. So soon as the flower buds appear they are carefully nipped off, except in the case of a few plants which are reserved for seed. All side shoots springing from the axils of leaves are also suppressed, and no plant is allowed to carry more than ten or twelve leaves.

Harvesting.

The cutting and curing has but little resemblance to the parallel operations in American tobacco culture. In Districts west of Allahabad the practice is to cut the plants down whole close to the ground, but in the Eastern Districts the leaves are often picked separately as they ripen. The plants or leaves are then allowed to lie on the ground and wilt for a period which seems to vary greatly in different Districts, and which is much longer when the plant is cut in February than when it is cut in April or May. This explains such discrepancies in the District reports as 12 to 16 days (Cawnpore, Allahabad and the Bundelkhand Districts), 5 or 6 days (Etawah, Agra and Muttra), and 2 or 3 days, or even less than this (Basti, Gorakhpur, Azamgarh, Bareilly, Moradabad and Saháranpur). Another explanation is offered by the fact that tobacco intended for chewing is left out on the ground nearly twice as long as that intended for smoking; in the latter case the leaves are carried in when of a black colour, and in the former case not until they have been burnt reddish brown (Etah). The leaves are carried in when damp with dew in the early morning, as so to run as little risk as possible of breakage. The process which follows resembles but little the elaborate curing practised in America, in which the leaves are hung in a closed house or shed. If the plants were cut down whole they are now stripped, and the leaves are then heaped in a mass for fermentation, being arranged with their apices pointing towards the centre of the heap and their stalks outwards. Occasionally the heaping is carried out in a hole or trench in the ground. They are allowed to remain in this condition for a period varying from three days to a month, fermentation being occasionally assisted by a sprinkling of water, which should be brackish if possible. The temperature is carefully watched, and immediately it rises too high the heap is opened out, the leaves turned over and made up again. When sufficiently fermented the leaves are pliable and can easily be made into "hands" or coils, which when finally dried are ready for sale. If no immediate market for them can be obtained they are "bulked," *i.e.*, heaped in a corner of the cultivator's house, or occasionally hung from the roof, until they find a purchaser.

Diseases and injuries.

Tobacco does not appear to be infested in this country with the multitude of cater-

pillars which are so much dreaded by the American planter. Indeed it is reported from some Districts that it is never attacked by insects at all. Sáwani tobacco, *i.e.*, that cut in February, occasionally suffers from frost in Districts west of Benares, where light frosts are of no unfrequent occurrence, while that not cut till April has much to fear from hail, which especially in Districts under the Hills, often entirely destroys the crop. The leaves occasionally suffer from the attacks of a kind of grey mildew, known as *kápti* in the Azamgarh District.

Cost of cultivation.

The cost of growing an acre of sáwani tobacco is shown approximately below:—

	Rs.	A.	P.
Preparation of seed bed, ...	0	10	0
Cost of seed, (say)	0	4	0
Cost of raising seedlings (watering, weeding and thinning for 2 months),	2	0	0
Ploughing field (ten times), ...	7	8	0
Making water beds, ...	0	3	0
Watering (eight times from canal), ...	12	0	0
Transplanting, ...	1	14	0
Weeding (four times), ...	3	0	0
Cutting, heaping, &c., ...	5	0	0
Total, ...	32	7	0
Rent (⅔rds of annual), ...	10	0	0
Manure (⅔rds of cost of 200 maunds), ...	4	0	0
Grand Total, ...	46	7	0

Average outturn.

Irrigation has been presumed to be from a canal, although such is very seldom the case, since it is otherwise almost impossible to calculate its real cost.

The District reports are extremely discrepant in the matter of average outturn, varying between a minimum of 3 and a maximum of 20 maunds per acre. Probably 10 maunds good tobacco, with 4 or 5 maunds broken leaf, is a safe estimate. If, as is generally the case with sáwani tobacco, a ratoon crop is taken from the same plants, another 5 maunds must be added to this.

Area.

The average area under tobacco during the last three years in the 30 temporarily settled N.-W. Provinces Districts is shown below:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur District only.	Benares Division, including Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.	Total.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Area under tobacco, ...	13,030	3,580	7,965	3,846	815	261	26	29,523

The area under tobacco in Oudh is much larger than this, and cannot be estimated at less than 58,000 acres, nearly two-thirds of which are engrossed by the Districts of the Sitapur Division. Adding 3,000 acres for the 5 N.-W. Provinces permanently

settled Districts, the total area is raised to about 90,500 acres, or to only ·26 per cent. on the total cultivated area.

The imports and exports of tobacco by rail during the last three years are given below:—

	1878-79. mds.	1879-80. mds.	1880-81. mds.
Imports, ...	1,41,224	71,194	84,010
Exports, ...	87,866	59,078	52,452
Net import, ...	53,358	12,116	31,558

The imports are almost wholly from the Lower Provinces of Bengal, and the exports to the Central Provinces, Rajputana and the Punjab.

Explanation of Plate XVI.

1. Flowering branch (nat. size).
2. Leaf (½ size).
3. Vertical section of flower (enlarged).

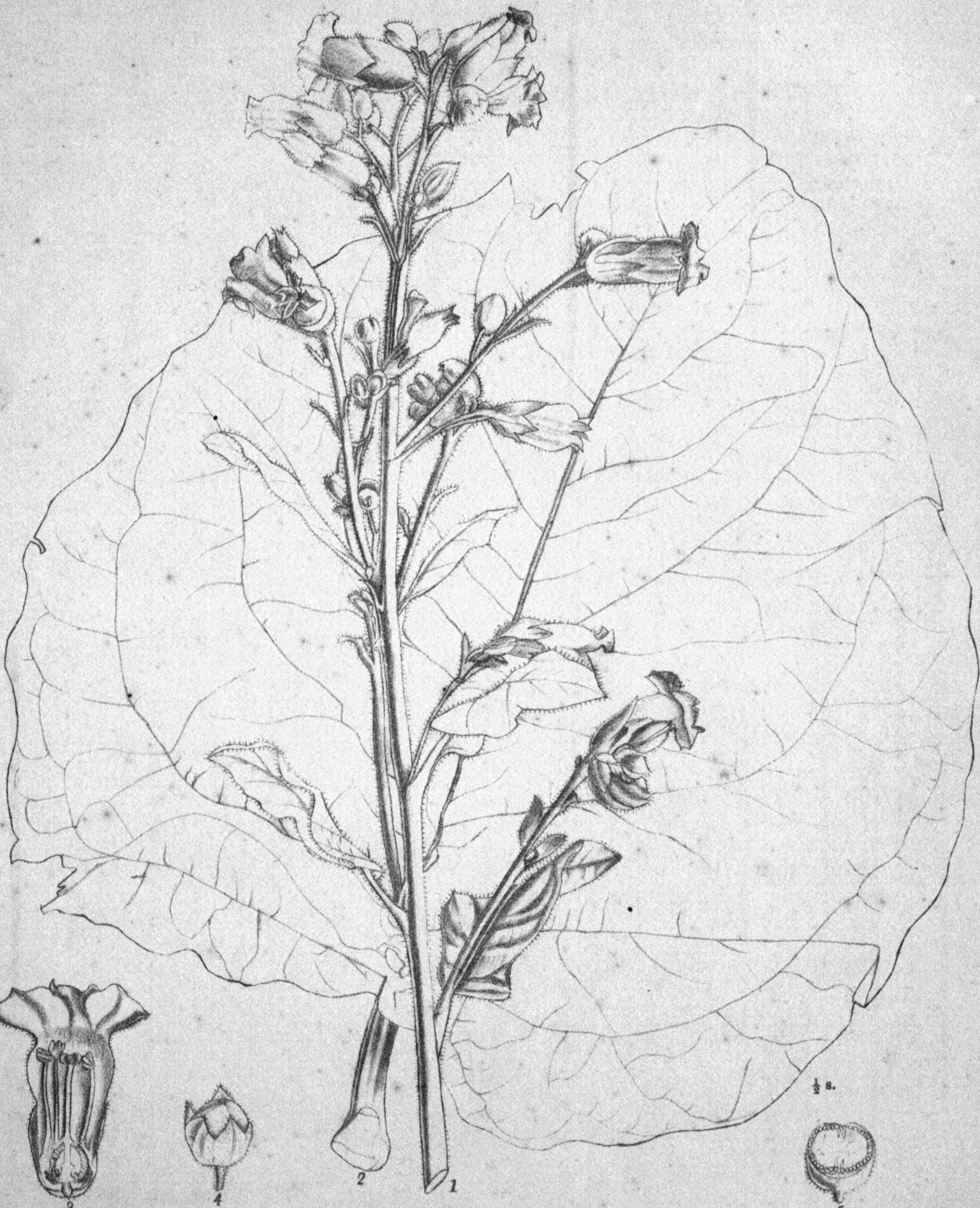
Explanation of Plate XVII.

1. Flowering branch (nat. size).
2. Lower leaf (½ size).
3. Vertical section of flower (enlarged).
4. Young fruit, } nat. size.
5. Transverse section of ditto, }

NICOTIANA TABACUM, LINN.

Drawn by H. Hormusji

Litho. T. C. Press, Roorkee.
Thos. D. Bona, Supdt.



NICOTIANA RUSTICA, LINN.

Drawn by H. Hormusjt

Litho. T. C. Press, Roorkee.
Thos. D. Bone, *Supdt.*

GOSSYPIUM HERBACEUM, *Linn.**

[*Vide* Plate XVIII.]

ENGLISH cotton; VERNACULAR bárí or ban (Districts west of Etah), kapás (Districts east of Etah), narma, manua, radya (varieties peculiar to the eastern Districts).

Description.

An erect shrubby plant belonging to the tribe *Hibisceæ* of the natural order *Malvaceæ*; annual or perennial,† more or less hairy. Stems 4-6 ft. high, woody. Leaves stalked; stipules falcate, lanceolate; blade about as long as the petiole, cordate at the base, palmetely lobed, lobes 5-7, ovate or lanceolate acuminate. Peduncles axillary, jointed, rather shorter than the leaves, 1-flowered. Bracteoles 3, large, cordate, dentate or nearly entire. Flowers large, yellow with a purple centre. Calyx truncate or obscurely toothed, shorter than the bracteoles, usually beset with black glandular dots. Petals obovate, cuneate, spreading. Stamens numerous, monadelphous; anthers 1-celled. Style clavate; stigmas 3-5. Capsule ovate, pointed, 3-5-celled. Seeds about 5 in each cell, ovate, covered with closely adpressed greyish or greenish down under the long white woolly hairs.

Varieties and allied species.

In addition to the cotton which is one of the staple crops of the western and southern Districts of the Provinces, there is a species known as *Gossypium arboreum* with much fleshier and more shining leaves (in this respect resembling somewhat closely American cotton), which is sparsely cultivated in parts of Oudh and the more eastern N.-W. Provinces Districts. It is ordinarily known as *narma* or *manua*, the terms which native cultivators invariably apply to American cottons, and a superior variety of it grown in the Allahabad District is called *radya*. Both these differ greatly from the ordinary cotton (*kapás*) in the season of their growth, not bearing cotton till the hot weather months instead of at the end of the rains.

Cotton is one of the leading agricultural staples of the Provinces, being grown on nearly 14,50,000 acres, or 5·8 per cent. of the total cropped area, and 11·0 per cent. of the area under kharif crops. Its production is, however, markedly localized, only attaining importance in the western and south-western Districts. This is shown by the subjoined figures:—

Cotton grown alone or with other crops.	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad Division, excluding Jaunpur.	Benares Division, including Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, including Tarai District only.
Percentage on kharif cropped area,	12·7	7·3	16·6	17·6	·2	12·7	2·5
Percentage on total cropped area, ...	6·2	3·8	9·1	9·6	·1	7·2	1·7

* **References**:—Hook. Fl. Ind. i. 346; Roxb. Fl. Ind. iii. 184; Wight Ic. t. 9 & 11; Royle Ill. t. 23. f. 1; Parlatore *Sp. di Cotoni*, p. 31, t. 2. According to Professor Todaro of Palermo, in his "*Relazione sulla cultura dei Cotoni*," published in 1877-78, the *G. herbaceum* of Linnæus is a distinct species from that above described. The latter with their varieties he places under two separate species whose synonymy is briefly as follows:—(1), *G. neglectum*, Tod. = *G. herbaceum*, var. 'China Cotton,' Roxb. Fl. Ind. iii. 185; Royle Ill. p. 98, t. 23 f. 1; & *G. herbaceum*, Wight Ic. t. 11 (Roxburgh's figure). (2), *G. Wightianum*, Tod. = *G. herbaceum* of Hook. Fl. Ind. i. 346, (in part); Wight Ic. t. 9; & *G. album*, W. & A. Prod. i. 54 (in part).

† Roxburgh says "biennial or triennial," but in this part of India it is usually treated as an annual.

The Districts in which its cultivation reaches its maximum are Aligarh, Agra and Banda, where it amounts to over 10 per cent. on the cultivated area. The produce attains its finest quality on the black soil of Bundelkhand, the produce of which sells in the Cawnpore market at from Re. 1 to Rs. 2 a maund higher than local produce.

Seasons.

Cotton is a kharif crop, being the one first sown after the commencement of the rains, and yielding its produce from October to January. This is with the ordinary variety, *narma* and *radya* cotton not bearing a crop till the April and May following their sowing, and thus occupying the ground for at least eleven months. Cotton fills no place in any special rotation of crops, although it is reported generally to succeed sugar-cane in Meerut, and to intervene between two cereal crops in Bareilly, the deduction being merely that it is grown on good land which had at all events been manured in the preceding year. It is off the ground too late to admit of its being followed by a rabi crop in the same year, but an ingenious method of gaining a second crop off cotton fields is to sow the oilseed *duán* (*Eruca sativa*) broad-cast amidst the crop just before it is finally weeded. The seeds are buried in the operation of weeding, and the *duán* plants do not become tall enough to interfere with the cotton until the latter has finished bearing.

Mixtures.

Cotton is comparatively rarely grown alone, being, as a rule, associated with four or five subordinate crops, amongst which *arhar* is the chief. The *arhar* is generally sown in parallel lines, not broad-casted, and it is said that the cotton plants find in its shelter some protection from cold winds and frost. The oilseed *til*, or *gingelly*, occupies first place amongst the remaining subordinate crops, which comprise the pulses *úrd* or *múng* sown broad-cast, and an edging of castor and of the fibre plant known as *patsan* (*Hibiscus cannabinus*).

Soils and manuring.

Cotton land may be either the very best or the very worst in a village. As a rule cotton is grown on good land, a loam being preferred, and is either manured itself or reaps some benefit from a manuring applied to the crop which preceded it. District returns show that about 23 per cent. of the cotton crop is grown on land manured specially for it, 39 per cent. on land manured in the previous year or two years, and 38 per cent. on land altogether unmanured. It will be seen that a very large proportion is grown with manure, but on the other hand it is a common crop on poor soils, such as the raviny calcareous tracts in the neighbourhood of great rivers, which it is said to actually improve by the manure of the leaves which fall from it. When sown on high class soils it is generally grown alone, while on poor ground it is almost invariably mixed with a large proportion of pulses and oilseeds. Hardly any of the Bundelkhand cotton, which is by far the best in the Provinces, receives manure, nor does the black soil on which it is generally grown appear to require it.

Tillage and sowing.

The land is ploughed from four to six times on the first fall of rain, and the seed is sown broad-cast at the rate of 4 to 6 seers per acre and ploughed in. The seed is generally rubbed with cowdung before sowing, which prevents it clinging together in masses as it would otherwise do, and is also said to stimulate its growth. Irrigation is only applied to one field in seven, and this much only in Canal Districts, where a watering will not cost more than from one to two rupees.

Narma cotton requires but little water, although it has the whole of the cold and

part of the hot weather to stand before it produces its fibre. But the *radya* variety is said to require copious irrigation. It is essential to the proper growth of the plants that they be kept free from weeds, and the ground is, as a rule, carefully weeded by hand at least twice in the season, and often four times.

The cotton bolls commence to open in October, and picking is in progress from then till the end of January, unless cut short sooner by frost,—the great enemy of the cotton plant. Good fields are picked every third or fourth day, but only between sunrise and mid-day, while the cotton remains damp with the night's dew and comes away easily. If force is necessary to separate it from the boll, bits of pod-shell come away with it, which are technically known as "leaf," and greatly damage the commercial value of the produce. Cotton picking is generally done by women, who are remunerated by receiving $\frac{1}{8}$th to $\frac{1}{11}$th of the pickings. For "ginning" or separating the cotton fibres from the seed, a simple but ingenious machine is used (called a *charkhi*), consisting of two small rollers about a foot long (one of iron the other of wood), each with one end turned into an endless screw, and so geared one into the other, that when one—the wooden one—is turned by a handle the other also turns in the opposite direction. When cotton is applied to the rollers the fibres are drawn through, and are in this way parted from the seeds. With this instrument a woman can turn out from 4 to 5 lbs. of clean cotton fibre a day. The proportion of fibre and seed varies considerably, being in great measure dependent on the quality of cultivation. Occasionally it rises so high as $\frac{2}{5}$ths and falls as low as $\frac{1}{4}$th, but $\frac{1}{3}$rd is the general average. It is interesting to note that an instrument practically identical with the *charkhi* is used for cotton cleaning by the negroes of the Southern States of America.

Injuries and diseases.

Stagnant water, especially at the commencement of its growth, is most harmful to the cotton plant, and fields selected for cotton are, as a rule, those in which water does not lodge. Rain when the pods have commenced to open is also most damaging, since the fibre becomes discoloured and rotten. Early frosts may altogether terminate the picking season a month or six weeks before it would otherwise have ended, and hence the cagerness shown to get the cotton seed into the ground as soon as possible. Caterpillars are often very destructive, sometimes stripping a field entirely of its leaves, and an immense deal of loss results from the ravages of a small white grub (called *súndi*) which lives within the pod.

Cost of cultivation.

The cost of cultivation is estimated below:—

					Rs.	A.	P.
Ploughing (four times),	...	...	...	...	3	0	0
Clod crushing (twice),	...	...	...	...	0	4	0
Seed (nominal),	...	...	...	...	0	2	0
Sowing,	...	...	...	...	0	13	0
Weeding (twice),	...	...	...	...	3	0	0
Picking ($\frac{1}{10}$th produce on 200 lbs.),	...	...	...	...	4	0	0
Cleaning (at 1½ anna per 10 lbs.),	...	...	...	...	1	14	0
			Total,	...	13	1	0
Manure (100 maunds),	...	...	...	...	3	0	0
Rent,	...	...	...	...	6	8	0
			Grand Total,	...	22	9	0

Average outturn.

There is no crop the outturn of which has been so systematically underrated as that of cotton, and if we are to believe the District reports of the last three years, the Provincial average is only 59·8 lbs. per acre, in which case it may be demonstrated that it would not pay to grow it at all. After consideration of the estimates arrived at by Settlement officers, which exhibit, it must be said, the most astounding discrepancies, and utilizing the experience of two years on the Cawnpore Farm, an all round estimate of 170 lbs. of clean cotton per acre of irrigated, and 150 lbs. per acre of unirrigated, land is the lowest which can be safely struck, except for Oudh and the Benares Division, where 100 lbs. may be taken as sufficient. For cotton mixed with *arhar* these outturns should be reduced by about 25 per cent.

The average area under cotton during the three years 1878 to 1880 in the 30 temporarily settled N.-W. Provinces Districts is shown below:—

	Meerut Division.	Rohilkhand Division.	Agra Division.	Allahabad, excluding Jaunpur.	Benares Division, including only Azamgarh, Gorakhpur and Basti.	Jhansi Division.	Tarai District.	Total of 30 temporarily settled Districts.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Cotton alone.								
Irrigated, ...	73,601	1,065	13,273	1,435	27	426	192	90,019
Unirrigated, ...	1,26,101	66,819	89,733	1,03,758	2,108	37,001	2,459	4,27,979
Total, ...	1,99,702	67,884	1,03,006	1,05,193	2,135	37,427	2,651	5,17,998
Cotton and Arhar.								
Irrigated, ...	34,010	827	27,082	4,244	207	467	6	66,843
Unirrigated, ...	81,599	1,04,051	2,53,103	3,12,519	3,226	53,716	406	8,08,620
Total, ...	1,15,609	1,04,878	2,80,185	3,16,763	3,433	54,183	412	8,75,463
Grand Total, ...	3,15,311	1,72,762	3,83,191	4,21,956	5,568	91,610	3,063	13,93,461

The annual District returns show the area under cotton in Oudh and the 5 permanently settled N.-W. Provinces Districts to be about 56,000 acres, which brings the total average up to close upon 14,50,000 acres.

Below are given the *net* exports by rail for the last three years—

	1878-79. mds.	1879-80. mds.	1880-81. mds.
To Calcutta,...	4,39,041	9,00,950	10,22,339
Elsewhere, ...	87,246	1,81,429	1,75,581
Total, ...	5,26,287	10,82,379	11,97,920

This account would be incomplete without some notice of the efforts which have been made by Government (especially during the period succeeding the American war of 1864) to improve the cotton produce of the country and stimulate traffic in it. Numerous "Model Farms" were started, and efforts made to acclimatize foreign varieties and to hybridize the indigenous ones, but with little or no success, except in the Dharwar tract

PLATE XVIII.
H—1.

Drawn by H. Hormusji.

GOSSYPIUM HERBACEUM, L.

Litho T. C. Press, Roorkee.
Thos D. Bona, Supdt.

of the Bombay Presidency, where an improved variety extensively grown owes its origin to these endeavours. It has been proved that good American cotton can be grown in this country but at a cost in manure and tillage which practically places it beyond the means of all but the wealthiest cultivators. The intrinsic merits of the indigenous cotton when properly grown and carefully harvested appear to have been too often lost sight of, and much labour has been spent in trying to introduce foreign varieties which might perhaps have been more profitably directed towards attempts to improve the variety of the country. The fibre of the *narma* variety has a poor reputation, but a broker's report kindly obtained by Mr. T. Wyer, in charge of the Dubâri Court of Wards Estate in the Azamgarh District, shows that with careful cultivation it may attain great excellence, while in a report drawn up by Dr. Forbes Watson in 1878, the conclusion is arrived at that "one half of the whole bulk of American cotton imported into England could be matched as regards length of staple by cotton grown in India."

Explanation of Plate XVIII.

1. Portion of a flowering branch.
2. A single leaf.
3. Vertical section of flower.
4. Cluster of capsules.
5. Single capsule closed.
6. Transverse section of capsule.
7. Capsule opened showing the cotton.
8. A seed with its coating of cotton.
9. A seed with the cotton removed.
10. Transverse section of ditto.

CANNABIS SATIVA, *Linn.**

[*Vide* Plates XIX and XX].

ENGLISH, **hemp**; VERNACULAR, **bhang.**

Description.

Natural order *Urticaceæ*, tribe *Cannabineæ*. A coarse tall annual with palmately divided leaves and small green dioecious flowers. Stems 3-10 ft. high, often woody at the base, closely and finely tomentose; branches slender. Leaves alternate or opposite, on slender grooved petioles, with linear acute stipules at the base, leaflets 5-7, of the upper leaves fewer, linear, lanceolate, tapering at each end, deeply serrate, dark green above, pale and mealy beneath; midrib and veins prominent. Flowers unisexual, small, greenish. Male flowers many, terminal and in axillary drooping panicles; perianth segments 5, almost free, spreading or recurved, boat-shaped, downy, acute, margins hyaline; stamens 5, opposite the perianth segments, filaments very slender. Female flowers fewer, axillary, sessile, erect, bracteate; perianth a single entire leaf, opening at the side, and enclosing the ovary, 5-veined, glandular; ovary ovoid, smooth, containing a single pendulous ovule; style short; stigmas 2, long, exserted; fruit small, enclosed in the persistent perianth, smooth, brownish-grey; seed completely filling the pericarp; embryo curved.

Distribution.

Although the hemp plant is not uncommon in gardens in all parts of the Provinces, its systematic cultivation is restricted to the Himalayas and the belt of country lying immediately beneath them. It is grown in most parts not for its familiar virtues as a fibre producer, but on account of the intoxicating nature of a resinous juice which exudes from, or resides in, its stalks, leaves and flowers, and which constitutes under many forms and preparations one of the most popular and most characteristic narcotics of the East.

The virtues of the hemp plant appear to vary very greatly with the locality of its growth. Although it is a common jungle plant along the Himalayan Tarai, no use whatever is made of its fibre, and its cultivation as a fibre plant is restricted to the inner vallies of the Himalaya. There is also a striking difference in the nature of its narcotic product under different circumstances. On the dry plateau of Central Asia a gummy exudation appears on the flowers and leaves, which when rubbed or scraped off forms the drug known as *charas*. This exudation is also gathered from the hemp plant grown in the Himalaya in the locality where its fibre is found to repay extraction. In the plains of India the plant will not produce *charas*, and in order to obtain its intoxicating secretion, it is necessary to gather the parts of the plant which contain it; when these are the immature female flowers and floral envelopes the product is known as *gánja*, when they are the leaves it is the *bhang*, *sabzi*, or *siddhi*, a decoction of which takes the place of alcohol with a large portion of the Hindu population. On the other hand it is said that *gánja* is not yielded by the plant when grown in the Himalaya, and although its leaves are used as *bhang*, they are reported to be of most inferior quality.

Cultivation.

The plant is grown in the Himalaya on elevations between 3,000 and 7,000 feet, forming as a rule small patches at the corner of villages, which the daily offices of the inhabitants provide with a plentiful supply of manure. It is notorious that hemp requires great richness of soil, and there is a proverb in Italy (where the finest hemp

* **References**:—Linn. Sp. Pl. Ed. I. p. 1027; Roxb. Fl. Ind. iii. 772; Bentley and Trimen Med. Pl. 231; Powell Punj. Prod. 292. *C. indica*, Lam.; Drury Useful Pl. of Ind. 106.

CANNABIS SATIVA, L., ♂

Drawn by H. Hormusji.

Litho T. C. Press, Roorkee.
Thos D. Bona, Supdt.

CANNABIS SATIVA, L., ♀

Drawn by H. Hormusji.

Litho T. C. Press, Roorkee.
Thos D. Bona, Sculpt.

fibre in the world is produced) to the effect that it will *grow* anywhere, but without manure will be fit for no use though planted in heaven itself. The seed is sown in May, at the rate of 30 seers to the acre, and the plants are thinned out if they come up too closely and are kept carefully weeded. By September they will have attained a height of 12 or 14 feet. In the hemp the male and female organs are contained in separate flowers and borne on separate plants. The male plants (called *phúl bhang*) yield the best fibre, and they are cut a month or six weeks before the female plants (*gul bhang*), which are allowed to stand until their seed ripens. The next process is the collection of the *charas*, which is done by rubbing the seed pods and leaves between the hands. The stalks are then laid in water to promote a fermentation, which will allow the bark to strip easily; on being taken out they are beaten with mallets to loosen the bark, which is then detached by hand in strips, and after a second beating breaks up into a fibre which is made up into hanks for sale. In some places the fibre is boiled in potash and bleached before spinning. The principal things manufactured from it are hemp cloth (*bhangra* or *bhangela*), and the ropes which are used for the swing-bridges over hill streams. The cloth makes an admirable material for sacks, and is largely used in the grain trade on the Nepal frontier; and, latterly, in the export of potatoes from Kumaun. It also furnishes a large portion of the hill population with a characteristic article of clothing—a hemp blanket, worn like a plaid across the shoulders and fastened in front with a wooden skewer. Other uses to which the fibre is applied by the hill men have been described as "hanging their supernumerary female "children, ropes-ending their wives, penning up cattle and making a sort of netted, or "knitted, or knotted shoes, to which a sole of untanned leather is sometimes, but by no "means generally, affixed."

The seed—of such repute in Europe as a food for cage birds—is not uncommonly roasted and eaten by the hill men. Occasionally oil is expressed from it, and the oil cake given to their cattle.

The outturn of an acre of hemp in Garhwál is given by Captain H. Huddlestone, who enquired into the matter in 1840, as "three seers *charas*, worth Rs. 6, four maunds "of hemp fibre, worth Rs. 8, and from 30 to 35 seers of seed, yielding some five "seers of oil, worth a rupee."

It may be mentioned that hemp growing is restricted to the lowest classes of cultivators, being considered beneath the dignity of the higher castes. "So* much is this the case, that the phrase 'may hemp be sown in thy house' is one of the commonest abusive imprecations."

Explanation of Plate XIX.

1. Upper part of plant,
2. Leaf from lower part of plant,

} nat. size.

3. Side view of flower,
4. Ditto seen from above,

} enlarged.

Explanation of Plate XX.

1. Upper part of plant,
2. Fruit,
3. Seed,

} nat. size.

* Kumaun Gazetteer, Vol. I., page 801.

CROTALARIA JUNCEA, *Linn.**

[Vide *Plate* XXI.]

ENGLISH, **false hemp, san hemp, tág hemp**; VERNACULAR, **san, sani, sanai, phúlsan, arjha san.**

Description.

Natural order *Leguminosæ*, sub-order *Papilionaceæ*, tribe *Genisteæ*. A tall stiff shrub with slender virgate stems, 4-8 ft. high. Branches terete, striate, silky. Leaves shortly stalked, distant, linear lanceolate, 1½-3 in., entire, obtuse, clothed with shining reddish brown silky hairs, stipules (when present) small, subulate. Flowers numerous, in long loose terminal racemes; bracts small, linear or ovate acuminate. Calyx deeply toothed, densely clothed with rust-coloured pubescence; teeth linear lanceolate. Corolla bright yellow; keel closed, slightly twisted. Stamens diadelphous, unequal; anthers of the shorter stamens linear, of the longer ovate. Pod 1-1½ in., clothed with persistent velvety pubescence. Seeds numerous, kidney-shaped.

The *sanai* is closely connected with the broom, to which both in flowers and foliage it bears considerable resemblance. Fibre is actually extracted from a species of broom (*Spartium junceum*) found wild in the south of Europe. The generic name of the sanai (*Crotalaria*) is derived from the rattling noise made by the loose seeds within the ripe pods when the latter are shaken.

It is unfortunate that this and the plant next noticed (*Hibiscus cannabinus*) should have borne amongst Europeans the name of hemp, and have thus been subject to ever-recurring confusion with the true hemp plant, *Cannabis sativa*. The similarity, and indeed in some cases identity of the vernacular names of this and the Hibiscus hemp (*patsan*) has also contributed to the error and uncertainty which occur in the writings of most unscientific enquirers into the fibre products of Upper India. There is indeed no affinity whatever between the three plants. Hemp is a species of nettle with much divided hand-shaped leaves; sanai-hemp is a leguminous plant with prominent yellow flowers, hardly *primâ facie* recognizable from *arhar* (*dal*), except in having undivided instead of divided leaves, whilst patsan belongs to the same order as the cotton, which it greatly resembles both in flower and shape of leaf. In the following notes patsan will be the name used to denote the latter, whilst the plant which this notice concerns will be styled as sanai, the commonest of its vernacular names.

Distribution.

Sanai does not form one of the heads in the annual crop returns, so that no data are possessed for the calculation of the average area under it in different parts of the Provinces. From special returns collected in 1880-81, it appears that the area under sanai grown as a sole crop in the 30 temporarily settled N.-W. Provinces Districts is between 38,000 and 40,000 acres, being ·16 per cent. on the total cropped area, and ·3 per cent. on the area under kharif crops. The divisions in which its cultivation is most popular are Rohilkhand (10,000 acres), Allahabad (10,000 acres), and Agra (8,000 acres). In the Meerut Division it occupies less than 3,000 acres, partly it is said because the rival fibre, patsan, is grown in this division to a larger extent than in the Middle and Lower Doáb.

* **References.**—Hook. Fl. Ind. ii. 79; Roxb. Fl. Ind. 259; Powell Punj. Prod. 507; Drury Useful Pl. of Ind. 163.

Season.

Sanai is one of the kharif crops, and is sown at the commencement of the rains and cut at the end of September or beginning of October. It is commonly off the ground in time to be followed by a rabi crop in the same year. The seed does not ripen until November, but experience has shown that the plants should be cut down when in flower to obtain the best possible outturn of fibre. According to some authorities it impoverishes, and according to others it improves land, the truth lying between the two assertions. A rabi crop following it will certainly be inferior to one succeeding to a summer fallow, but on the other will be far superior to one grown after such indubitably exhausting crops as *chari* or maize.

Mixtures.

It is a common border to fields of juár or cotton, but is by no means seldom grown alone. It is sometimes used to "clean" land, since the closeness of its growth effectually stifles all weeds which may attempt to compete with it.

Soils and manures.

A light sandy soil gives the tallest plants, possibly because the roots can penetrate deeper. Authorities differ as to whether a rich soil is necessarily required, and although there can be no doubt that fertility in the soil is necessary to promote great luxuriance in its vegetation, yet it cannot be contested that sanai will grow on poorer land than almost any other crop. One possible explanation of this may lie in the theory that plants of this order can assimilate nitrogen direct from the atmosphere, and are hence less dependent on the soil for nourishment, and another explanation may be deduced from the fact that its roots penetrate deeper than those of most other crops, and can hence draw supplies from a larger body of soil.

In any case ploughing in a green crop of hemp is known to add considerably to the fertility of the surface soil by increasing its stock of nitrogen, and it is extraordinary that this is not a general practice with native cultivators.

Tillage and sowing.

Two ploughings at most are given, and the seed is sown broad-cast at the rate of one maund to the acre and ploughed in. It germinates quicker than any other crop, the seedlings showing above ground within 24 hours after being sown. Irrigation, even when necessary, is rarely given, and no weeding is required.

Harvesting.

The tops are cut off and given to cattle when the plants are in full flower, and the stalks are then cut down close to the ground with a sickle, or (in some places) pulled up by the roots. When stripped of the leaves they are ready for retting. The stalks are made up into bundles and placed upright for a day or two in water about a couple of feet deep, since the bark on the butts of the stalks is thicker and more tenacious than that on the upper portion, and requires therefore longer exposure to fermentation. The bundles are then laid down lengthways in the water, and are kept submerged by being weighted with earth. The time required for retting varies from three days in hot and damp weather to seven days if the temperature be cool and the air dry. The longer the stalks are kept in water over the proper time the more the fibre gains in whiteness of colour and loses in strength. The next process is that of beating, or more properly "washing," which takes the place of both "breaking" and "scutching" in the European process of fibre preparation. The "washing" is effected by a man standing in water to his knees, who takes a bundle of stems and perseveringly threshes the water with them. The bark is split up and detached by the resistance of the water, and by skilful manipulation is washed off in continuous strips, which are only connected

with the stalks at their thick ends, held in the operator's hand. The stalks are in this way completely peeled of bark, and come out of the process perfectly white. They are fit for nothing but fuel. The fibre is then cleaned or "drawn" by the skilful fingers of women and children, and is made up into hanks for sale or use. The process may be taken as a fair sample of the ingenuity which the Indian peasant has derived from centuries of practical, although unreasoning, experience.

"Washing" is a severe labour, and cannot be carried on by one man for more than three hours at a time. An expert and energetic washer can turn out from 7 to 8 seers of clean fibre in three hours, and about 15 seers in a day, which represents the outturn of between 5 and 6 maunds of plant. A woman will clean and "draw" 8 to 10 seers of fibre daily.

The fibre of the sanai is commonly known as *arjha san*, and that of patsan as *lattia san*. Lattia san is much the whiter and silkier of the two, but is also much the weaker, and commands about 18 per cent. lower price. Arjha san is principally used for well ropes, string, and fishing-nets, lattia san being preferred it is said for fabrics such as *tát* or gunny.

Cost of cultivation.

The cost of cultivation is given below:—

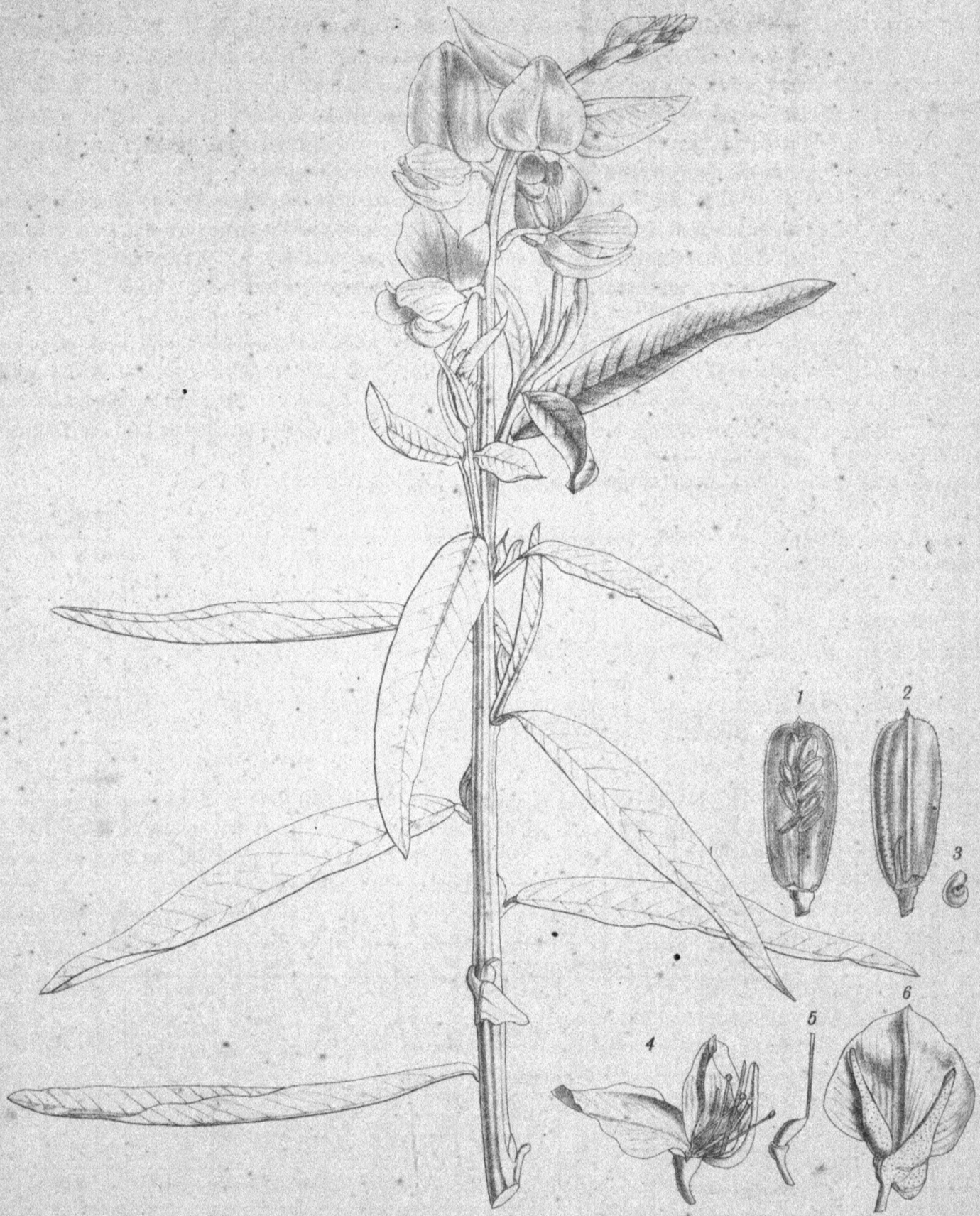
	Rs.	A.	P.
Ploughing (twice), ...	1	8	0
Clod crushing (once), ...	0	2	0
Seed (1 maund), ...	0	12	0
Sowing, ...	0	13	0
Cutting, ...	1	9	0
Washing (a crop of 8 maunds fibre), ...	2	10	0
Drawing, ...	3	0	0
Total, ...	10	6	0
Rent, ...	5	0	0
Grand Total, ...	15	6	0

Average outturn.

The average outturn is about 8 maunds (or 640 lbs.) of clean fibre to an acre, worth about Rs. 20. The value of arjha san has suffered great fluctuation in late years. The Settlement officer of Allahabad writes, that in 1877 its price was as high as 6 seers per rupee, whilst a few years back it stood at 20 seers.

The area under sanai as a sole crop in 28 of the 30 temporarily settled N.-W. Provinces Districts in the year 1880-81 is shown by divisions below:—

	Meerut Division.	Rohilkhand Division.	Agra Division, excluding Etawah.	Allahabad Division, excluding Banda and Jaunpur.	Benares Division, Azamgarh, Basti and Gorakhpur Districts only.	Jhansi Division.	Kumaun Division, Tarai District only.
	acres.	acres.	acres.	acres.	acres.	acres.	acres.
Irrigated, ...	720	87	1,711	902	19	2	8
Unirrigated, ...	2,261	10,048	6,083	9,035	2,717	2,359	228
Total, ...	2,981	10,135	7,794	9,937	2,736	2,361	236



CROTALARIA JUNCEA, L.

Drawn by H. Hormusji

Litho. T. C. Press, Roorkee.
Thos. D. Bona, *Supdt.*

Explanation of Plate XXI.

1. Pod cut vertically to show the seeds,
2. Ditto entire,
3. Seed,

} nat. size.

4. Flower with one wing removed,
5. Pistil,
6. Flower seen from behind,

} nat. size.

HIBISCUS CANNABINUS, *Linn.**

[Vide *Plate* XXII.]

ENGLISH, **roselle hemp**; VERNACULAR, **patsan, pitwa, san, lattia san, ambári,** (South India.)

Description.

Natural order *Malvaceæ*, tribe *Hibisceæ*. Annual or perennial. Stems 2–3 ft. high, terete, glabrous, but more or less prickly. Leaves alternate, on long prickly petioles, dark green above, paler beneath; lower ovate cordate, entire or serrate; upper deeply 3–5-palmately lobed; lobes narrow, lanceolate, serrate; stipules subulate. Flowers axillary, nearly sessile; bracteoles 7, sepal-like, subulate, shorter than the calyx, rough with bulbous-based bristles. Calyx bristly, glandular; sepals connate. Corolla large, bright yellow with a crimson centre; petals 5, connate below with the staminal tube. Stamens monadelphous; anthers reniform, 1-celled. Ovary 5-celled. Capsule globose, pointed, bristly, opening through the back of each cell (loculicidally). Seeds almost glabrous.

Uses.

Patsan is one of the numerous family to which the ornamental hibiscus, the bombax or silk cotton tree, the cotton plant, and the *bhindi* belong, and possesses in the shape of its stem-leaves a passing resemblance to the true hemp. It yields a fibre which is softer, whiter, and silkier than that of the *sanai*, but on the other hand of much less strength, and which, therefore, commands a considerably lower price in the market. Its fibre is not so much esteemed as that of sanai for well ropes and coarse cordage, but is perhaps the best fitted of the two for the making of coarse cloth or sacking. It is also in request as a material for the thin ropes (*dol*), which are used for drawing water for drinking purposes. Its young foliage is eaten as a vegetable, and its seeds when roasted are an article of food like those of its near relative the *bhindi*, *Hibiscus* (or *Abelmoschus*) *esculentus*. It is reported that in the Meerut District a use is found for its dry stalks as matches, they being split and tipped with a preparation of sulphur.

Distribution.

No details whatever are available of the area under patsan, but it is believed to be grown on a much smaller scale than sanai. It is very rarely cultivated as a sole crop, and most commonly occurs as a border to fields of sugar-cane, cotton, and indigo. The best patsan in the Cawnpore market is imported from the Meerut division and the Northern Districts of Oudh, and it is probable, therefore, that these are the localities in which its production is largest. In ordinary Doáb Districts it is only met with as a sparse bordering to some kharif fields, and is merely grown for the domestic use of the cultivator.

Cultivation.

Its cultivation will necessarily be similar to that of the crop with which it is associated, and thus it will be sown in February if as a border to sugar-cane, May if a border to *jamowa* indigo, and July if a border to cotton. When ripe the plants are cut down close to the ground or are pulled up by the roots. It is important that none of the lower part of the stem be lost since this contains the best fibre. The stalks are then kept submerged in water for a period varying from 6 to 10 days according to the

* **References**:—Hook. Fl. Ind. i. 339; Roxb. Fl. Ind. iii. 208; W. & A. Prod. i. 50; Powell Punj. Prod. 504; Drury Useful Pl. of Ind. 248.

HIBISCUS CANNABINUS, L.

Drawn by E. Hormuzjf.

Litho T. C. Press, Roerkst.
Thos D. Bona, *Supdt.*

weather, when the bark can be easily pulled off by hand in long continuous strips. The method of extraction is, therefore, much simpler than that of sanai. If the stalks are kept in water too long the fibre loses very greatly in strength, although gaining in colour.

Its outturn will of course vary very greatly with the thickness and width of the border in which it is sown, and the degree to which it is overshadowed by the crop which it surrounds. Estimates vary between a maximum of 125 seers and a minimum of 20 seers to the acre.

Explanation of Plate XXII.

1. Portion of flowering branch,
2. Single leaf,
3. Flower vertical section,

} nat. size.

4. Capsule enclosed by calyx,
5. Vertical section of ditto,
6. Seed.

} nat. size.